

NELSON MANDELA
UNIVERSITY














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Entities in
SERVICE OF SOCIETY

Index of entities

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Contents

Foreword: A Different Kind of Wave	2
eNtsa – Innovation through Engineering	3
Advanced Mechatronics Technology Centre	9
merSETA Chair in Engineering Development	10
Renewable Energy Research Group (Mandela Uni Autonomous Operations)	11
Women in Engineering Leadership Association	15
STEM in Action.....	17
Isuzu Chair of Mechatronics	20
Chair for Education in Human Settlement Development and Management	21
Centre for Community Technologies.....	25
Southern Africa Cisco Academy Support Centre	30
Infrastructure Development and Engagement Unit	32
Cross Laminated Timber Engagement Unit.....	33
Maritime Training Centre	35
Marine Robotics Unit	36
Centre for Research in Information and Cyber Security	38
Built Environment Research Centre	40
Advanced Engineering Design Group.....	42

FOREWORD:

A Different Kind of Wave

It may be hard to find light in the darkness at the height of the pandemic's second wave. Still, perhaps the most valuable consequence for higher education is that it forced us to re-imagine ways in which to reach and engage students, our industries, and communities. The online experiment has provided unexpected insights on what is possible if technology is optimally leveraged in our sector.

What you hold in your hand is a summary of the extraordinary achievements of the research and engagement entities in our Faculty during the most challenging time in our history. I'm still humbled and surprised by the speed, depth and scope of our Faculty's response to assisting our communities and industries during the pandemic.

Our Centre for Community Technologies (CCT), for example, pioneered ICT and mobile application innovations, including rolling out a COVID-19 screening tool to 5100 schools in the Eastern Cape. It

About Professor Barend van Wyk:

Professor Barend van Wyk has a PhD from the University of the Witwatersrand and has been an academic for 15 years. He has more than 12 years of industrial experience in telecommunications and aerospace engineering and extensive management experience. He is a National Research Foundation rated researcher and has published more than 100 peer-reviewed conference and journal papers since 1998. Prior to joining Nelson Mandela University, he was the Executive Dean at the Tshwane University of Technology.

also provided the ICT support for Nelson Mandela Bay's 1501-bed Rev Dr EM Chabula-Nxiweni Field Hospital, which is the only paperless public sector hospital in Nelson Mandela Bay. During the pandemic, the Advanced Engineering Design Group (AEDG) worked with local specialists to develop an intubation unit and hospital theatre accessories to prevent contagion in operating theatres, and eNtsa 3D-printed 14 000 medical face shields, primarily for frontline medical workers in the Eastern Cape.

I am convinced that, if the pandemic had happened a decade ago, almost none of these extraordinary feats would have been possible, since technologies to support them were still in their infancy. Indeed, the Fourth Industrial Revolution (4IR) is not a future event; it is happening now. That some sectors of the economy could survive COVID-19 – and higher education could continue for many learners – are direct consequences of 4IR technologies.

These are a few cherry-picked examples of more than 550 industry and community projects during 2019 and 2020! While extraordinary for such a small faculty at a South African university, it is still a tiny drop in the ocean in the context of growing our ailing economy and creating much-needed employment.

The pandemic has shown us that we need to strengthen our efforts to use 4IR technologies to help companies build a networked economy, where the focus is on an interconnected ecosystem of shared value and distributed work.

What we do in our Faculty's entities reflects

the motto of Nelson Mandela University: *Change the World*. It is a very emotive motto for me. By remaining *in service of society*, we are creating a different kind of wave.

– Professor Barend van Wyk





Dr Davies Tsikayi replaces the laser metal deposition head on the laser for research at eNtisa

eNtisa – Innovation through Engineering

How Nelson Mandela University's eNtisa entity uses engineering in the service of society is marked by one generic characteristic: innovation. In keeping with this, the entity's name, eNtisa, is derived from the isiXhosa word eNtsha, meaning "new".

As eNtisa director Prof Danie Hattingh puts it: "To be engaged in an engineering domain where we strive to develop solutions to extend the life of aging infrastructure, while at the same time embrace advanced automation and control methodologies, requires adaptability and the willingness to respond rapidly to the demand of a sustainable lifestyle for all."

eNtisa has a team of 60 and numerous members of the team have won national awards and international

acknowledgement for their groundbreaking research and applications, within the friction processing arena in particular. In 2020 the Suid-Afrikaanse Akademie vir Wetenskap en Kuns (South African Academy for Science and Art) awarded Prof Hattingh an Honorary Medal of the Faculty of Natural Science and Technology.

"Innovation through Engineering", however, is a boundary-less action which goes beyond technology and engineering to become a decision-making directive. In this, eNtisa is supported by four core values:

- Teamwork
- Integrity
- Innovation
- Excellence

By using these values as its "engagement law", eNtisa engineers are obligated

to be ethical in their attempts to solve problems, with an appreciation of social implications. This approach safeguards industry and public confidence in a rapidly changing world driven by the advancement of technologies, many of which challenge our self-created comfort zones.

Engineering in the service of society also means a change in the culture of engineering in higher education, which must be done without compromising the "integrity" of knowledge and skill transfer. For eNtisa, this "integrity" lies embedded in a youth mentoring approach, ensuring that it educates an engineering cohort who can address the complex challenges of the future, expressing their professionalism and engineering ability through constructive engagement with people and the environment.



eNtsa's small punch testing facility provides creep rupture and materials characterisation data using small sample methodologies

Research and Engagement through innovation

eNtsa contributes to industry with a vast range of specialised services aimed at supporting and stimulating local innovation through supplier development initiatives. eNtsa is acknowledged internationally as an innovation hub that supports research, design and technology assimilation for the broader manufacturing sector, with a focus on the automotive, power generation and petrochemical industries. The institute now has an annual turnover of some R50-million, generated from industrial and government contracts for assistance with research, design or process development.

The advanced design and modelling capabilities at eNtsa provide a comprehensive range of mechanical design and consulting services, which range from mechanical parts or system design, through to simulation of parts or systems by advanced finite element analysis (FEA).

Mechanical and material testing services focus on providing professional metallurgical services in the field of failure

"Due to its focus on innovation, eNtsa has always placed a high value on applied research with the accent on student development, linked to added commercial and engineering value."

investigation and assessing process/production-related material challenges.

Other services include material conformance testing with regard to material microstructure, chemical composition, environmental and mechanical properties.

The Training Academy initiative supports efforts focused on supplier development by providing skill development interventions to University staff and students, local industry and the community at large with a focus on engineering and technology trends..

eNtsa's industrial Research and Innovation (R&I) focuses on expanding research and technology transfer, particularly in the field of batteries, small sample material evaluation, friction hydro-pillar processing, heat treatment solutions and laser processing (complex cutting, welding and metal deposition). The main R&I effort is to contribute new knowledge that will assist with managing the engineering challenges associated with safely prolonging the life of high value components; in certain instances, well beyond the original design life.

eNtsa Technology Station Programme

The main focus of the Supplier Development and Technology Station Programme (TSP) within eNtsa is to support and stimulate the local manufacturing and engineering industries to improve the competitiveness of local manufacturers, which will enable industry to exploit and develop new markets.

eNtsa is able to make much-needed engineering skills, high-tech services, and training more readily available to small and medium enterprises (SMEs) operating in the local manufacturing sector.

In the 2019/20 financial year, the eNtsa Technology Station Programme completed 500 industry assistance projects for local companies. This industry assistance covers a wide spectrum of testing, design, product/process development, technology demonstrations and manufacturing assistance.

During this period, 121 different SMEs were supported through 192 engineering projects. The annual target for this technical assistance is 125, and the total of 121 equates to 97% of this target.

In the same period, 308 projects were completed for 59 different large companies, with an average of 25 large companies assisted each quarter.

Projects designated as facilitating export readiness enabled the production of components or products destined for export markets. Of the projects completed in 2019/2020, 75 had a direct impact on export readiness.

Student development

In addition to formal knowledge transfer training activities, eNtsa also hosts a number of Work Integrated Learning (WIL) programmes with under- and postgraduate students as interns and Graduates in Training (GIT). This

programme allows young engineering professionals to gain hands-on experience and develop a broader understanding of engineering work requirements, skills and tools. In 2019/2020, eNtsa hosted nine interns and GITs, and four of these have since received job opportunities within the industry.

Due to its focus on innovation, eNtsa has always placed a high value on applied research with the accent on student development, linked to added commercial and engineering value.

eNtsa has developed a research roadmap, which is now being implemented to strengthen research endeavours. The main areas for applied academic research are:

- charging infrastructure and battery technology for e-mobility
- laser processing with an emphasis on complex geometry Laser Metal Deposition (LMD) components and fatigue



Students receive valuable hands-on experience at eNtsa and several other EBET entities



Electric and hybrid-electric vehicles are part of the uYilo e-Mobility Technology Innovation Programme

- solid state joining technologies for titanium and aluminium sections and life prediction/extension models via small sample testing for high-value engineering plants
- localised heat treatment of thick-walled High Pressure High Temperature (HPHT) components
- life extension of engineering structures based on Small Sample Testing Methodologies.

Postgraduate student numbers have increased, rising from 12 in 2016 to 16 in 2020. There is a steady output of journal articles, ranging from five to 10 per year, and participation in two to three conferences per year, even in the COVID-19 year of 2020.

uYilo e-Mobility Technology Innovation Programme

Started by the Technology Innovation Agency (TIA) and hosted within eNtsa, uYilo is a multi-stakeholder collaborative programme to enable, facilitate and activate electric mobility (e-mobility) in associated sectors in South Africa. Its activities extend across government lobbying, industry cohesion, enterprise development, thought leadership and skills development.

uYilo is profiled as a strategic initiative within the national Department of Transport's Green Transport Strategy (2018-2050), in which Strategic Pillar 8 promotes electric and hybrid-electric vehicles.

uYilo has since established a foundation of specialised expertise and key infrastructure towards accelerating the growth of e-mobility in South Africa. Facilities include a national accredited battery testing laboratory, materials characterisation laboratory, vehicles systems laboratory for component level support and a smart-grid ecosystem that provides a live testing environment for universal interoperability.

In the 2019/20 financial year, uYilo continued to serve on a number of national initiatives that enabled the uptake of e-mobility in South Africa. As a member of the Department of Energy's South African Smart Grid Initiative, uYilo provided input into relevant policies, legislation and the national direction for e-mobility technologies into smart grids.

Engineering Innovation: Whip peening

The whip peening innovation was first conceived as a theoretical solution

having specific ties to the unique peening requirements associated with steep groove surface treatment. It would also be feasible to be implemented with the existing equipment developed by eNtsa to perform the serration grinding procedure.

This innovation involves a series of small high-strength tungsten beads, spun at a determined peripheral velocity to get a desired kinetic energy. The beads are constrained in a spherical dimension about the rotational centre by means of a strong, but flexible link (wire, thread or line) allowing partial degrees of freedom to the rotating beads. The beads travel in a planar circular motion owing to the centrifugal reaction force of bead mass and centripetal acceleration creating a whipping action. When the whipping beads are brought into contact with a target surface, the kinetic energy of the beads is transferred to the local contact area, giving a peening action. With accurate position control, machine parameters such as peening intensity and indentation spacing can be repeatedly achieved regardless of the whip radius.

The development of a prototype whip peening tool has gone through various conceptual iterations and, after suitable testing, a final tool has been designed

and fabricated. The experimental testing performed provided extremely positive results, indicating the process is effective at inducing a residual stress state in a confined space.

The process and technology has been successfully demonstrated to Eskom, which took samples for independent testing. Its test measurement concurred and Eskom is satisfied with the process for future implementation on turbine rotor serrations.

Supplier Development: Technology Station Programme SME project: Bellingham and Smith

Sports equipment manufacturer Bellingham and Smith (B&S) in Thornhill, Eastern Cape, identified a need to increase its cricket bat manufacturing technology. eNtsa developed a prototype 4-Axis computer numerical

eNtsa developed a prototype 4-Axis computer numerical control (CNC) wood router in January 2018, supported by DSI scale-up funding.

control (CNC) wood router in January 2018, supported by DSI scale-up funding. Since then, hundreds of bats have been machined on this system, with a daily output increasing.

B&S needs to continue upscaling production capabilities with further custom machining to allow it to increase output and upskill its workforce. The aim of this project was to develop a bespoke, industrial CNC wood router with three cutting heads to increase production and reliability.

Productivity figures before and after eNtsa intervention highlight the impact of this technology transfer package. Before eNtsa's assistance, it took 50 minutes to machine at stock shape, which a prototype platform cut to 25 minutes. Using a new 3-spindle CNC wood router platform, this time was further reduced to eight minutes. Bat production has risen



eNtsa worked with cricket bat manufacturer Bellingham and Smith to develop a wood router to speed up production



eNtsa engineers prepare for site application with Weldcore® technology

from an initial 22, to 35 and then to 50 bats per day.

In addition to improving productivity by 127%, B&S indicated that the quality of the final product has improved, as bat shapes are consistent. The firm can now produce a wider range of shapes and sizes, and supply a greater market. By increasing the overall capacity of B&S, this Technology Transfer Package has given B&S the potential to create employment for the Thornhill community, improve sustainability of the company and create opportunities in export markets.

B&S has begun upskilling staff to increase output demands, and approximately 1000 bats were produced in February and March 2020, just ahead of the pandemic and national lockdown. B&S is negotiating new local and international contracts based on this new capacity.

Other projects

The eNtsa team is also evaluating innovative ideas involving scuba equipment.

Faced with the challenges of COVID-19 in 2020, eNtsa has been working with a consortium of companies and Walter Sisulu University on the reverse engineering and manufacturing of the Nuffield 200 ventilator system.

Training Academy: Skill and competency development for power plant staff

eNtsa has addressed the skills capacity gap in the power generation industry, more specifically within Eskom, through the Eskom Power Plant Engineering Institute (EPPEI) and eNtsa. This has led to an agreement to create a platform to bridge this gap within the South- and southern Africa power generation industry.

Eskom established the institute in 2012 to increase skills capacity of its engineers.

Part of this drive includes the Operators, Maintenance and Engineering Practitioners initiative, which aims to create the opportunity for plant personnel to advance their knowledge, leading to an increase in their technical competence, allowing for more efficient operation and maintenance of power plants.

It gives all plant staff the chance to advance their knowledge and increase their technical competence, allowing more efficient operation and maintenance of power plants.

The objectives of the Engineering Practitioner Training Programme (EPTP) are as follows:

- To give engineering practitioners the opportunity to gain a thorough understanding of their job activities, including engineering fundamentals, and practical plant operation and maintenance requirements.
- To provide engineering practitioners with an accredited certification of professionalism in their job profile.

There is a two-phase approach: Phase I focuses on delivering short courses by using a set-out building-blocks method to ensure that the necessary resources are engaged, and milestones reached, to execute the project effectively.

Phase II aims to establish a formal, nationally accredited qualification with the assistance of higher education institutions.

This will allow Eskom staff to obtain a formal qualification, while working, by attending accredited modules offered via the Engineering Practitioner Training courses.

In the 2017/2018 project year, the EPTP initiative reached 424 individuals across an array of courses, where 200 training points were the target.

In 2019, it reached an additional 379 points and in 2020 (the pandemic year), 41 points, giving a total of 844 training points so far.

Advanced Mechatronics Technology Centre

The Advanced Mechatronics Technology Centre (AMTC) enables faculty staff, students, alumni and partners from diverse communities and locations – local and global – to collaborate strategically to:

- advance human capacity and community potential
- improve social, educational and scientific progress
- strengthen the economy through scientific and technological innovation, and new business growth
- promote social justice and cultural diversity
- inspire creative expression and entrepreneurship.

As an engaged centre, the AMTC works in service of society with various units and programmes operating under its umbrella, such as Manufacturing, Engineering and Related Services SETA (merSETA) Engineering Development. Other entities in the AMTC are:

- The research entity of Renewable Energy Research Group (RERG) and Mandela Autonomous Operations (MAO)
- Women in Engineering (WELA)
- SANRAL's STEM in ACTION
- Siemens Training Centre.

AMTC research outputs

The AMTC is a registered engagement unit with a philosophy of supporting

research. Funding generated by the Siemens Training Centre and merSETA defined projects supports human resources required for lecturing, laboratory maintenance and research. Besides human resource capacity, the centre also supports student projects, postgraduate research, and international exchange programmes as well as the purchase of infrastructure for the operation of the Centre.

Student financial support

In the 2019 financial year, the centre contributed R1.8-million in financial support to 20 students, including three doctoral and seven master's students. Bursaries from the merSETA Chair in Engineering Development contributed a



Saliem Dolley, left, and Dr Sean Poole providing quality assurance on Cobot robots



The merSETA appointed contract lecturer Thabelo Mohlala to lead the Mechatronics division for World Skills SA

further R1.35-million in financial support to a further 20 undergraduate students. In 2020, the merSETA supported 31 engineering students.

Ikusasa bursary scheme

The Ikusasa Financial Aid Programme (ISFAP) had an enrolment of 53 students for 2019. Ikusasa aims to improve academic performance through “wrap-around support”, which includes programmes that will assist the student beyond the classroom.

One of its focus areas is to provide much-needed mentoring and guidance in the engineering field.

Students took part in a range of workshops, talks and activities, including hiking and mind-mapping in 2019, designed to cover areas as diverse as stress management, gender-based violence, team building, goal setting, time management, integrity and challenges, and reviewing academic goals. All of the Ikusasa programmes at Mandela University align with the Engineering Council of South Africa (EXCSA) graduate attributes.

Human resource development

AMTC appointed Thabelo Mohlala as a contract lecturer for the Higher

Certificate (Mechatronics). The merSETA appointed Mohlala as the national expert to lead the Mechatronics division for World Skills SA.

merSETA Programme in Engineering Development

The merSETA Programme in Engineering Development at Nelson Mandela University was established in 2010 to grow human resources in the School of Engineering. The end goal of this is to make the manufacturing industry in the Eastern Cape more competitive and contribute to a growing and sustainable economy. Its objectives are to:

- increase capacity at FET colleges
- promote women in engineering
- create an awareness of the relevance and importance of engineering at schools in rural areas of the Eastern Cape
- increase the capacity of educators at technical high schools in the Eastern Cape
- develop specialist training courses to address the needs of the manufacturing industry
- assist in the development of new technologies in manufacturing (renewable energy).

In 2019 and 2020, the merSETA Chair in Engineering Development projects included the following:

Industry 4.0 laboratory upgrade

This project, which is aligned with the merSETA Sector Skills Plan, which addresses the merSETA’s strategic focus areas of Innovation and Partnerships, includes the upgrade of an existing laboratory at the Department of Industrial Engineering at Nelson Mandela University.

This focuses on the development of Industry 4.0 technologies, upskilling of university and TVET college staff of engineering programmes, partnering with local industry, training local industry staff, and integrating these latest technologies into undergraduate degrees and postgraduate projects.

Three technical staff (former and current university students) were employed including an industry mentor to train and guide the interns and project staff on industry standards. Various engineering interns were also employed to assist in component design and manufacture.

The technical concept for the new production line came about through an

extensive survey of the requirements of Industry 4.0, as well as through consultation with industry experts, including Siemens and Festo.

In the new concept, the production line is entirely integrated, featuring 12 individual stations with a mix of sensors, scanners and actuators that will provide the basis for smart production strategies in a mass customisation paradigm. The line also includes the integration of cobots and autonomous vehicles (AGVs).

Over 800 hours of training have been provided directly and indirectly, upskilling staff according to the needs of the project, as well as informing and training staff to provide better quality training to students and others.

The hardware conversion (splitting and upgrading of the assembly line) was completed in February 2020. Once COVID-19 restrictions were relaxed, a team of interns, staff and students completed various milestones:

- Siemens Wonderware software update and commissioning
- commissioning of split conveyor system, with RF ID pallets and wireless barcode scanners
- assembly and wiring of 12 panels to control the line, which was almost entirely assembled by intern students
- installation, commissioning and integration of four Cobot Robots
- development of a phone app and related software
- development integration of three Automated Guided Vehicles
- development of a two-day workshop called "Introduction to Industry 4.0".

Although the project has undergone major delays, due to issues both linked and independent of COVID-19, it has continued to make progress and is looking positive for completion in early 2021.

Vision-based deep learning algorithm for detecting potholes

This project aims to automatically detect a pothole and inform the driver of the pothole before approaching it. The project also aims to share with other drivers the data which is collected.

In 2019, the School of Engineering established a new Department of Marine Engineering. This programme, funded by the merSETA since 2015, was completed in March 2020.

MEng Mechatronics students Kanushka Gajjar and Francis Le Roux spent time in Germany as part of their postgraduate studies. Gajjar worked on Pothole Identification at Ostfalia University of Applied Sciences in eastern Lower Saxony, and Le Roux worked on State-of-Health Monitoring of Li-Ion Batteries at Ingolstadt in Bavaria.

merSETA Marine Engineering

In 2019, the School of Engineering established a new Department of Marine Engineering. This programme, funded by the merSETA since 2015, was completed



The Renewable Energy Research Group harnesses wind and solar energy at Riemvasmaak in the Northern Cape

in March 2020. Finnish company Wärtsilä made a major donation of marine equipment, which has been placed in the new engineering building on the University's North Campus.

Renewable Energy Research Group (Mandela Autonomous Operations)

The Renewable Energy Research Group (RERG) and Mandela Autonomous Operations (MAO) are research entities within the AMTC which have a clear understanding of the need to be part of the solution to real-world engineering challenges. Collaboration and group-thinking are the key to solving these challenges.

"We focus on understanding the needs of South Africans in a South African environment," says Prof Russell Phillips, manager of RERG and MAO. "We focus on tangible outcomes that improve the lives of people and assist the economy in a sustainable manner while involving, and hence educating, learners and the community. With the synthesis of input from all engineering and scientific disciplines, innovative, solid solutions grow from the ground up in record time."

Despite the challenges posed by the COVID-19 pandemic, RERG and MAO continued to develop many projects in 2020, though several were managed remotely through online resources. The following action-based research projects are underway and the hope is that they will lead to commercialisation.

Riemvasmaak solar and wind project

Riemvasmaak in the Northern Cape has the highest solar energy in the country with temperatures reaching 50° Celsius in summer and the desert landscape receiving less than 50mm of rainfall annually. This is where Nelson Mandela University's School of Engineering for a number of years has performed solar and wind energy research, benefiting a small farm, a guesthouse and the community as well as students who have not only learnt by doing the practical work, but also realised their value to the community.

The Riemvasmaak project is run by the AMTC and funded by the Manufacturing,

**Riemvasmaak
in the
Northern
Cape has the
highest solar
energy in the
country with
temperatures
reaching 50°
Celsius in
summer and
the desert
landscape
receiving less
than 50mm
of rainfall
annually.**



Riemvasmaak guesthouse owner Elisa Namases welcomes Karl du Preez, left, and Prof Russell Phillips to the farm

Engineering and Related Services SETA (merSETA).

In 2020 the first live research site was established on the farm, feeding research data to the University and the guesthouse owner, Ms Elisa Namases, who grew up on the farm, signed a formal Memorandum of Understanding with the University. A second set of solar panels was established, as well as two wind turbines to assist in supplying electricity to the guesthouse and to pump water.

Riemvasmaak is an example of engineering research being used in service of society, using de-urbanisation as a solution not only for the effects of climate change, but also to help alleviate poverty. So far, the following systems have been manufactured and installed at this site:

- vertical and horizontal wind turbines with an output of 400W and 500W respectively
- photovoltaic off-grid solar solutions with a solar capacity of 1000W (for the house), and 11.88kW (for the water pump).

This project was shared at a University Engagement and Transformation Portfolio – Hubs of Convergence webinar “Conversation 3: The Sciences in Service of Society” in November 2020. Prof Phillips, AMTC head Karl du Preez and lab intern Kabelo Mpurwana, as well as Riemvasmaak guesthouse owner Elisa Namases, were the presenters.

Peristaltic solar driven water pump

AMTC intern Kabelo Mpurwana developed a peristaltic solar-driven water pump for rural communities that need low-cost solar water pumping with minimal maintenance. The pump has been designed and is currently undergoing durability testing.

Solar process air heater

The solar process air-heater project is an extension of the master's treatise of student Ruben van Tonder, titled “The development of an optimised low-cost solar air heating system using evacuated tubes for industrial process heat”. The task is to improve the system regarding design of the framework, handling,

weight, efficiency, heat transfer to an algae pond, and commercialisation. The goal is to connect the solar air heating system with an algae pond on site at InnoVenton at the University. The system will be used to control the temperature of the water of the pond to ensure optimal algae growth.

The design has been refined by German exchange students, and mechatronics master's intern Ziqamo Mpi is working on the final design. The system should be manufactured and assembled in the first quarter of 2021. An additional project is the design of a control system to control the pH levels of the algae pond.

IGEMS and high school interventions: Wind turbine development

Incubating Great Engineering Minds (IGEMS) invited the AMTC to take part in an education-to-employment programme. MAO drone technologist Damian Mooney took part in the Wind Turbine Development programme and a roadshow to a rural school, demonstrating drone technology.

Solar-powered boat race

Every year the AMTC offers an opportunity to the University staff, students and industry members to participate in a solar-powered boat race. In 2019, the centre entered boats from various departments: Mechatronics, Marine, Mechanical and eNtsa, as well as three boats from industry. RERG's Prof Russell Phillips narrowly won the race and the student boat came in second. Unfortunately, COVID-19 put the 2020 boat race on hold.

Solar flight: Long endurance aircraft

A final year Mechatronics student completed an ultralong endurance autonomous drone with the aim of monitoring wildlife. The project tested the endurance of solar charged battery pack to achieve long endurance flights.

Mandela Uni autonomous operations

The University and the merSETA started an autonomous vehicle project in 2018, which includes the design and development of autonomous vehicles for aerial, ground and maritime environments. Over 2019 and 2020, much progress was made. A number of projects were completed, where students

could improve their skills, enhancing their career prospects in regional and national industry.

Students and staff completed the design of a marine glider and also designed, manufactured and tested a quadcopter for the security industry.

Marine autonomous systems: Marine glider

The merSETA Autonomous Operations project has contributed to the establishment of a Marine Robotics Unit (MRU) at the Nelson Mandela University. Expertise is also developed through internship opportunities made available through this project. Novel underwater robots research has led to collaboration opportunities with French universities and Norwegian partners.

Staff and students were exposed to the technologies required for underwater autonomous operations in Marine Robotics during the 2019 Solstice research activities. The second phase of the project, from June 2020, was to start building the prototype. The outcomes of Year 1 included a full CAD design, which includes all standard parts and relevant calculations.

There is additional collaboration with the Norwegian Government through an INPART project application, which is designed to facilitate collaboration, teaching and research sharing through international partnerships. Norges Teknisk-Naturvitenskapelige Universitet in Trondheim, Norway, will be the partner.

Ground autonomous vehicle: Agriculture

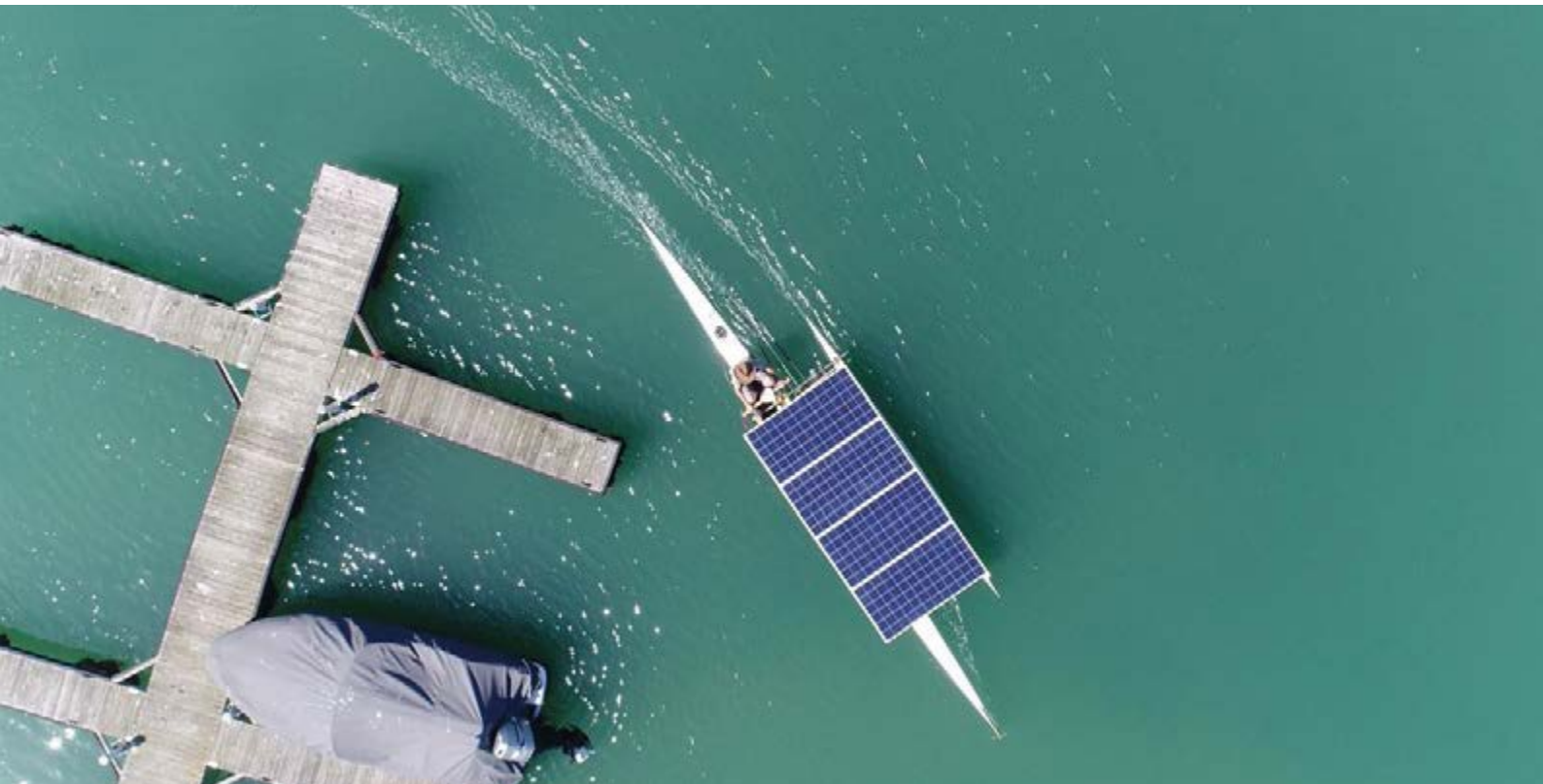
Doctoral student James Sewell has completed the design and manufacture of a vision-based autonomous ground vehicle (AGV) to perform various tasks on agricultural crops. The main objective of the vehicle is to transverse fields autonomously, visually identify crop species and weeds, and then perform tasks such as weed removal, watering and spraying.

As part of supporting local manufacturing businesses, an arrangement was made with Grindex Engineering CC, in Gqeberha (Port Elizabeth), to assist in manufacturing various components for the vehicle.

Aerial systems

Beyond Visual Line of Sight system

Two projects, including a beyond visual



The AMTC organises an annual solar-powered boat race

line of sight (BVLOS) system, were completed in late 2019 by student Shaish Gopichand, and updated in 2020 by master's student Jacques Welgemoed. The final long-range testing will continue once the ROC is received. These are:

- Test Platform – VTOL transition demonstrator. This is a fixed wing airframe able to hover and transition to and from forward flight and has been used to validate and test the control systems for the larger VTOL project.
- Test Platform – Multirotor High Endurance Hybrid Power demonstrator. This is a 3m diameter, 25kg multirotor electric platform able to accept various flight controllers and combinations of both solid-state battery power and fossil-fuelled, generator-derived power for long endurance flights.

Remotely Piloted Aerial Systems: VTOL

During the last quarter of 2018, a request was generated for a support craft to help

marine scientists deploy their autonomous ocean sensors out to sea. The requirement was for a Remotely Piloted Aerial Systems (RPAS) craft that could carry a minimum of 50kg of payload. It would have to take off from an unprepared surface (no runway) and travel to a position 50km out to sea before entering into a hover, lower the sensors into the ocean and then return to the point of departure.

After many case studies, the concept of a hybrid VTOL using both petrol and electric motors was decided upon and initial proof of concept work began in 2019.

In parallel, MAO began work on a 75% scale version of the proposed VTOL referred to as VTOL – Heavy lift Hybrid Power Marine Support Platform. Although 75% scale of the intended 9.3m version, the marine support platform has still been designed to carry 60kg of payload, making it a functional aircraft for the original requirement once tests are complete. The planned 9.3m VTOL is

designed to carry in excess of 100kg.

Individual motor run tests began in October 2020 with the aircraft tethered to a static platform. Further flights are required at an outdoor test facility, and were scheduled for early December 2020. The test flight test programme will continue into the third quarter of 2021, followed by certification.

Autonomous security drone solution

This project started in 2019, when master's student Benjamin Nelson designed and manufactured a prototype autonomous rotary drone. The drone is linked to a security company, in ready mode to receive any alarm activation. On an alarm signal, the drone deploys and, through visual object recognition, identifies various objects, then locks and follows the objects. While operating, the rotary drone provides a video link to the security company.

In February 2020, a Mechatronics master's student was assigned to optimise the



Mechatronics master's graduate Benjamin Nelson designed and manufactured a prototype autonomous rotary drone during his MEng studies



Jendamark mechanical engineering detailer Thandile Ndevu

rotary drone. The interface between the UAV (rotary drone) and base station are in development, specifically the precision landing software. The provisional completion date is June 2021.

Education: Aerial robotics

Fourth generation drone operating has shown a need for drone developers to move the focus from drone platform development to software development to allow for autonomous AI based operations. The discipline is referred to as aerial robotics with MAO taking the lead for South Africa by actively engaging with world leaders at Copter Express in Russia to develop a Robot Operating System based image-recognition capability for drone control at Nelson Mandela University.

To improve upon MAO's education capabilities, AMTC has entered students in numerous WorldSkills and BRICS international aerial robotics events, under the mentorship of drone technologist Damian Mooney. Mooney is an RPAS consultant in the AMTC, and appointed by the merSETA as the national expert to lead the drones division for World Skills SA.

Master's student Jacques Welgemoed, working on the security rotary drone, took part in the WorldSkills Asia, the

BRICS Future Skills Russia and BRICS International competitions in 2020. Welgemoed improved on his 2019 bronze medal at WorldSkills 2019 in Kazan, Russia, by finishing second in all three of the 2020 competitions. His most recent success was in Aerial Robotics at BRICS International in November, a competition

“Wela, isiXhosa for change or transition, was founded in 2012 to support female students in the School of Engineering to enhance their academic experience ...”

which, due to the coronavirus pandemic, was held online.

Women in Engineering Leadership Association (WELA)

The Women in Engineering Leadership Association (WELA) is one of five projects initiated and managed by the merSETA Chair in Engineering Development.

Wela, isiXhosa for change or transition, was founded in 2012 to support female students in the School of Engineering to enhance their academic experience and, more importantly, to assist them in successfully completing their studies.

WELA fulfils the Nelson Mandela University mandate of being of service to society through its focus on the academic, professional, and personal development of women in engineering. This programme includes various developmental workshops, outreach, several guest lecturers, academic support, meetings and gatherings, as well as a mentorship programme where senior WELA members are trained to mentor junior WELA members. In addition, WELA offers an Early Career Development



Nicole Truter, left, Associate Professor Ann Lourens, centre, and Mieshkah Dolley-Ryneveld at the 2019 Nelson Mandela University merit awards

programme to those working in the Science, Technology, Engineering and Production (STEP) field.

Industrial Engineering Head of Department Prof Ann Lourens, along with Project Coordinator Nicole Truter, manages WELA and outlines how it strives to create a culture of inclusion, equality and innovation.

"It means being aware of the needs of our female engineering students and practising female engineers and developing programmes and workshops to complement the academic skills acquired," says Prof Lourens.

"Engaged engineering means taking responsibility for fostering a sense of leadership that is centred around innovation, change and forward-thinking. Engaged engineering means that we focus on the development and support of women operating in traditionally male-dominated environments, creating opportunities to grow female engineers and attract more girls and women to the field. This is engaged learning, whether it is an educator's development or interacting with learners."

WELA continued to present events and workshops to members over the last 12 months to enhance their feelings of self-efficacy and improve retention rates of female engineering students.

Due to the restrictions of the COVID-19 pandemic, most workshops were offered to students on-line using Microsoft Teams. Events included the following:

- mentorship meetings and activities
- International Women in Engineering Day celebration
- "True Colours" workshop
- team building and Ubuntu workshop
- wellness and strengths assessment workshop
- Unleashing your Brain Power webinar, in collaboration with Emthonjeni Student Wellness
- Choices of a Successful Woman webinar
- forgiveness workshop webinar
- emotional intelligence webinar.

In 2020, WELA developed an animated promotional video for young female learners still attending school. This video promotes engineering as an academic subject and career opportunity for female learners.

WELA is also in the process of compiling stories from its members to publish as a storybook for primary school learners to encourage and educate them about the role of women in the field of engineering.

Throughout the lockdown, WELA and the Learning and Teaching Collaboration Cluster at the University, under the guidance of Ronel Plaatjies, provided academic and emotional support to the WELA students.

WELA also designed the ninth edition of the Inspirational Women and Inspirational Students (introducing new WELA members) publication. This is distributed at marketing events and to the manufacturing industry. Due to the pandemic, the 10th edition took on a virtual role and WELA highlighted inspirational women on its social media platforms.

STEM in ACTION

STEM in ACTION is a community engagement entity on the University's Missionvale Campus which supports learners, educators and parents across the educational phases through its "hands-on, brains-on" approach to learning

and teaching science, technology, engineering and maths.

This constructivist approach works in the service of society by motivating learners from Grade 3 to 12 to take an interest in these much-needed subjects and to consider possible careers in these fields. The entity falls under the auspices of the Advanced Mechatronics Technology Centre.

STEM in ACTION manager Isabel van Gend has seen from more than 10 years of working with diverse communities that few learners – regardless of their background – have an idea about careers in these fields.

“In addition, marginalised learners are not exposed to adequate ICT equipment and skills to engage in modern teaching activities and ways to search for information. This lack of skills and knowledge seriously disadvantages learners to function and make informed decisions,” says Van Gend.

A dynamic and enthusiastic STEM in ACTION team therefore consciously exposes learners to technologies, particularly where this applies to looking for information on academic matters and sharing information about careers and university applications.

Learners discover real-life careers by interacting with professionals and the workspaces of scientists and engineers. There is real and active connection with learners, and especially with mathematics and science educators.

This is evident on several Community of Practice platforms created for groups of educators.

All teaching and learning taking place at STEM in ACTION is aimed at engaged learning, whether it is an educator’s development or interacting with learners.

STEM in ACTION Operations Manager Tarin Roberts spells out the entity’s

practical nature: “We provide a space for learners to experience science by doing. We provide a multi-sensory learning environment where learners perform the experiments themselves and can see the colour change, they can feel the change in temperature, they can hear the collision and can even taste properties where possible.”

STEM in ACTION engages two groups, Group A and Group B, in more intense academic support activities and career exploration opportunities in science and technology.

From Group A, 451 learners have participated in the project since 2010 and at least 269 of those have gone on to choose tertiary education courses in science and technology. Numbers have grown, with 198 learners in 2010, rising to 2558 learners in 2019. So far 16 507 learners and 303 educators have taken part.

The Group B project started in 2016 with learners from under-resourced schools.



Newell High School Grade 10 learners (pictured pre-COVID-19) building a circuit on the STEM in ACTION programme



The STEM in ACTION team were ready for delivery to schools over the pandemic in 2020

The project exposes the learners to more intense academic support as well as career exploration.

The academic trajectory of these learners on average does not meet the minimum requirements to enrol for courses in science, technology and engineering.

However, STEM in ACTION results show that there is academic improvement for pupils on its programme, and 2019 saw the highest number registered for tertiary studies in science. Of 39 Gr 12 learners, 32 registered for tertiary studies, and 31 of these registered to study science and technology. This compares to the original number of 26 learners in 2016, where only 12 went on to study these subjects at a tertiary level.

In all, 133 Grade 12 learners have completed the project offering three years of academic support and career

exploration opportunities. In addition, 73 learners registered for tertiary studies, of which 69 enrolled for courses in science, technology and engineering. 2020 did, due to COVID-19, see a disruption in numbers, but the projects plan to resume in 2021.

Boost Prep Pack

During the pandemic lockdown, the team, together with their Physical Science Educators Community of Practice (CoP) forum, conceptualised the Grade 12 Boost Series.

Through this, matrics received an extra “boost”, with a Boost Prep Pack containing summary videos of their entire physical science curriculum, including the experiments. This encourages learners not only to work together with their educators, but also independently. The Boost Prep Pack includes a booklet with examination guidelines for physical

science, past exam papers, and memoranda, as well as a flash drive with 25 video episodes.

Funding partner SANRAL supported the initiative which brings the STEM in ACTION team, laboratories, and teaching into Grade 12 classrooms while adhering to COVID-19 safety regulations.

The learners were part of the STEM in ACTION after-school programme and visited the laboratories weekly to participate in an intensive Physical Science support session which includes exploring careers in STEM.

They were selected from high schools which include: St James Senior Secondary, Bertram Secondary, Morningside and Uitenhage High, Khwezi Lomso Comprehensive, Cillie, Cowan, Ethembeni, Gelvandale, Chapman, Collegiate Girls, Westering, Daniel

Pienaar Technical, Grey Boys, Alexander Road, Despatch, Pearson and Victoria Park High.

Technical Science Kit

In collaboration with the Advanced Mechatronics Technology Centre, STEM in ACTION has developed a complete Technical Science Kit per grade – Grades 10, 11 and 12 – to empower both learner and educator to conduct all experiments presented in the FET Technical Science curriculum.

Educators attended training at Missionvale campus and received kits for their learners to participate in groups to complete the Technical Science CAPS experiments. Kit contents include learner worksheets, educator guides and the memo for each experiment, and so far five technical high schools in Nelson Mandela Bay have received them: Khwezi Lomso Comprehensive School, Gelvandale Senior Secondary School, Ithembelihle Comprehensive School,

Newton Technical High School and Otto du Plessis High School. Subject to funding, this will be an ongoing project.

Siemens Training Centre

The Siemens Training Centre is fully accredited by the Siemens Automation and Controls training division and offers courses to engineering students, staff (CPD points) and industry customers. A range of automation courses is offered as stipulated by an annually renewable contract.

The Siemens certified training offered provides individuals with the confidence to effectively apply systems and optimise product usage. Knowledgeable employees with the correct training lead to shorter start-up times, reduced downtimes and faster troubleshooting.

Training for electricians, technicians and others in this field includes service and maintenance aspects of technology,

advanced programming, industrial networking, and supervisory control and data acquisition (SCADA) for technicians and engineers.

In 2017, the centre introduced the Totally Integrated Automation Portal (TIA-Portal) training suite which has seen a steady increase in numbers since starting in 2006 with 24 trainees. Delegate numbers were as follows: 239 in 2016, 338 in 2017, 387 in 2018, 301 in 2019 and 78 in 2020 (training shortened due to COVID-19).

The training centre has played a major role in developing the skills of engineers and technicians in the Eastern Cape and in other parts of the country, and will continue to work closely with Siemens SA to ensure individuals receive expert training on the latest Siemens equipment.

The training centre has trained more than 2500 individuals from industry over the past 15 years, and the training facility is regularly upgraded to world-class standards.



Isuzu Chair of Mechatronics



Mechatronics students helped to design foldable platforms for the assembly line at Isuzu in Nelson Mandela Bay

The Isuzu Chair of Mechatronics aims to establish new research and development trends, opportunities, and initiatives within the field of mechatronics. It facilitates the transfer of knowledge into teaching and learning concepts, and integrates this into undergraduate and postgraduate engineering programmes.

The Chair further seeks to strengthen international opportunities and cooperation between Nelson Mandela University, other national and international institutes of learning and the automotive industry. Through final-year and master's projects, the Chair is actively involved in industrial research and development, which also result in publications in international scientific journals.

"Through the long-term collaboration between academia and industry, the Isuzu Chair of Mechatronics makes a significant impact on human resource development,

benefits students, local industry, and the community at large," says Prof Igor Gorlach, who heads the entity.

"For longer than a decade, Mechatronics students have been actively involved in industry-based projects clearly demonstrating how successful and mutually beneficial a university-industry partnership can be."

This platform for international engagement, mentorship and practical industry research and development has facilitated numerous projects and boasts a strong project pipeline. Prof Gorlach meets engineering managers at Isuzu to identify suitable projects for Mechatronics students in their third and final (honours) years as well as master's students.

Student projects

The latest examples of student projects include:

- **Reconfigurable platform:** Develop a reconfigurable platform to support various types of trucks on the assembly line at Isuzu.
- **Robot Arm Tool:** Design a robot arm tool for holding door frames that could be automatically coupled and decoupled by a robot arm used on the robotic welding station for three models of bakkies.
- **Rear Axle Assembly:** Design a manual assembly line for rear axles. Isuzu envisaged in-house assembly of rear axles for its new generation of bakkies.
- **Fixture for the Robotic Welding Station:** Design a welding fixture for the envisaged Robotic Welding Station of Wheel Houses of the new generation of bakkies.
- **Rear Floor Robotic Assembly Station:** Design a special carrier/trolley to house Rear Floor Bases. Students also worked on an alternative material handling system/manipulator for transporting completed assemblies, instead of the current manually operated overhead hoist.

As part of undergraduate and postgraduate training, it is important to expose Mechatronics students to real-world industrial projects where they develop practical skills that serve them well in the job market. It is a principle of the Isuzu Chair of Mechatronics to enhance the BEng Mechatronics degree programme with the latest technologies applied in the automotive industry. It also sponsors trophies, prize money and awards for the top BEng achievers.

Academic support

The Chair offers the Mechatronics Mentorship Programme, which aims to address poor pass rates of first year Mechatronics students as the intake grows. Other goals are to create a better study environment to ease the transition from secondary to tertiary education, and assist students from previously disadvantaged communities. As a result of this initiative, the pass rate of first-year students has improved from about 50% to 66%.



In partnership with key stakeholders, academic and contract research on informal settlements is ongoing at Nelson Mandela University

Chair for Education in Human Settlement Development and Management

This entity is a national portfolio that supports the mandate of the Department of Human Settlements to professionalise the human settlements sector in South Africa. The Chair for Education in Human Settlement Development and Management (CEHSDM) aims to lead in providing advice and technical services in this sector in South Africa. It was established in 2012 through a Memorandum of Agreement concluded between the University and the national Department of Human Settlements. The Chair has since then led the introduction of formal human settlements academic programmes complemented by short learning programmes targeting those working in the three spheres of government, non-governmental organisations and the private sector.

“An engaged Chair for Education in Human Settlements Development

and Management seeks to optimise the benefits placed upon the EBET Faculty by the University to lead the development and maintenance of multi-disciplinary human settlements academic programmes at both under- and postgraduate levels,” says Professor Sijekula Mbanga in his role as Chair.

Goals of the Chair are:

- to professionalise the human settlements sector and related activities by providing advisory and technical services
- to develop and implement a degree qualification
- to develop and implement continued professional development programmes via short learning programmes (SLPs)
- to lead ongoing, sound and transdisciplinary research and innovation on the most pressing questions around envisaged future cities and human settlements
- as part of the South African Council for

Human Settlements Professionals, to investigate and support the establishment of a professional body.

Human Settlements degree qualifications

In 2014, the University launched a four-year professional Bachelor of Human Settlements Development academic programme which has since seen its first cohort of students graduating in 2018. This multi-disciplinary qualification has a core syllabus straddling affordable housing, property development and management, land-use planning and management, as well as public administration, development theory, sociology and law of human settlements. Plans are advanced for the introduction of a research-based Master of Human Settlement Development (to be completed with a dissertation at NQF Level 9) and a Higher Certificate in



Prof Sijekula Mbanga heads the Chair for Education in Human Settlement Development and Management

Human Settlement Development (to be completed through coursework that is pitched at NQF Level 5).

Short learning programmes

A suite of short learning programmes (SLPs) is offered to members of parliament, councillors, traditional leaders, and other government officials. Topics include sustainable human settlement planning, informal settlement upgrading theories and practices, social housing facilitation and administration, housing finance, housing business processes, project management, construction management, the theory of land use planning and management, property development and investment, property law and property valuation.

Sustainability research

Sustainability-oriented research for cities and settlements aims at forging new paths to solve complex societal problems

including the impact of climate change, poverty and inequality. The Chair will use methods that promote co-creation of knowledge between the University, community organisations, industry and international partners.

Ndlambe EcoSUN Green Village: International collaboration

The Ndlambe EcoSUN Green Village project in Ekuphumleni Township in Kenton-On-Sea is typical of the University's innovative community engagement research, pursued in a trans- and inter-disciplinary manner and anchored on a strong multi-sector engagement framework.

The EcoSUN Green Village promotes science and technology transfer between South Africa and Germany, facilitated by Nelson Mandela University in South Africa and the University of Potsdam in Germany. It also involves participation and cooperation choices made by the

“This entity is a national portfolio that supports the mandate of the Department of Human Settlements to professionalise the human settlements sector in South Africa.”

German Department of Education and Research, the South African Department of Science and Innovation (DSI), the Department of Human Settlements, the National Home Builders Registration Council and the Council for Scientific and Industrial Research (CSIR).

The project aims at offering scientifically proven solutions for key challenges facing the human settlements sector in this country. It does this in particular through the application of innovative technologies for water recycling and renewable energy use, organic waste management and green landscaping as well as education, job creation, enterprise development and support.

In essence, the project tries to show how a climate-change responsive settlement can be designed from scratch, using innovative technologies, harnessing multi-stakeholder participation and streamlining internal and external funding streams, and building sustainable communities in the Eastern Cape.

The project has also sought to introduce a Community Green Village Technician professional. This research and development involves Germany's Berlin-Brandenburg Vocational Institute and Technical University of Berlin as well as the Port Elizabeth and East Cape Midlands TVET colleges. This is supported by European funding at Potsdam University, and implementation managed by Nelson Mandela University.

Academic and contract research on informal settlements is ongoing in partnership with the Nelson Mandela Bay Municipality, the Eastern Cape Department of Human Settlements and

Lund University in Sweden. This research explores innovative interventions to improve the quality of life of low-income urban settlements. The idea is to involve communities in finding long-lasting solutions to their challenges.

Key issues explored include:

- access to energy
- solid waste management
- local economic development
- decongestion of densely populated settlements to curb the spread of communicable diseases
- addressing barriers to uptake of innovative building systems

- alternative water and sanitation solutions.

Partnership with Department of Science and Innovation

The Chair, which operates within the University's Research Group on Environmental Stewardship and Sustainable Livelihoods, has since 2015 been cooperating with the DSI Unit on Innovations for Inclusive Development.

Through the DSI cooperation, the Chair has been collaborating with the Technology and Innovation Agency (TIA) towards establishing a Community of Practice for Science, Technology and Innovations for Sustainable Human Settlements. Key objectives are:

- to foster stronger networks with international research institutions in generating innovations for sustainable human settlements
- to identify and collaborate on research topics that will involve DSI participation with international research institutions on human settlements innovations and housing technologies
- to support and facilitate networking with South African research institutions whose work supports the DSI agenda for sustainable human settlements
- to produce and publish knowledge products that support Science, Technology and Innovations for Sustainable Human Settlements.

COVID-19 response in human settlements

The South African government has undertaken a number of interventions in consultation with civil society. Below is a summary of current informal settlements interventions and challenges, including University interventions led by the Chair:

National government

A COVID-19 Informal Settlements Coordinating Committee was established in April 2020 to mitigate the effects of the pandemic in vulnerable communities such as those people staying in informal settlements, dilapidating and overcrowded inner city buildings and rural areas. It focuses on access to food relief, sanitisers, water supply, sanitation,



The challenge of illegal electricity connections, called 'Izinyoka,' is prevalent in a number of informal settlements across the Nelson Mandela Bay Metropole

facilities management of evictions in response to land invasions and measures for addressing overcrowded settlements (de-densification). Parallel to this Stakeholder Forum has been a policy review group focusing on implications of the Disaster Management Regulations to the human settlements sector and development of the Partnership Framework Agreement with civil society and its engagement plan.

Mandela University took part in this consultative process, facilitated by the National Upgrading Support Programme Unit in the national Department of Human Settlements, along with the University of Johannesburg, University of the Witwatersrand, National Treasury City Support Programme, NGOs operating in the housing and land sector, Housing Development Agency and the CSIR.

Eastern Cape

The University has had engagements with the Eastern Cape DHS and the metropolises of Buffalo City and Nelson

Mandela Bay on capacity support in their pandemic response in vulnerable communities. These bilateral meetings led sharing information on interventions underway, and planned for the medium and long-term. A Memorandum of Understanding for 2020 to 2024 between the University and the Eastern Cape Department of Human Settlements was submitted in March, but signing has been delayed due to COVID-19.

The Eastern Cape National Upgrading Support Forum was activated and meets once a quarter, with the last meeting held on 8 September 2020. Lack of operational and technical capacity and inability to enumerate and control growth of informal settlements were cited as key challenges, and the Chair is engaged with the DHS to find sustainable solutions.

Nelson Mandela Bay

Close interaction with Nelson Mandela Bay on informal settlement intervention cooperation started in 2018, which has led to identifying eight informal settlements (out of 94) for a University-

“The Chair, ... has since 2015 been cooperating with the DSI Unit on Innovations for Inclusive Development.”

Metro collaboration for improving the quality of life of residents over three years. The Mayoral Committee endorsed the partnership programme in February 2020 and resolved to enter into a Memorandum of Agreement with the University towards its implementation.

With the outbreak of COVID-19, discussions have continued between the University and the Metropole with a focus on a pilot programme in Walmer and Vistar-us-Rolihlahla informal settlement sites. Discussions have also explored cooperation on water scarcity challenges facing the municipality. During this period the University, through its Convergence Fund, has donated food parcels and other household amenities to vulnerable households of Walmer Area E, Vistar-us-Rolihlahla in Gqeberha (Port Elizabeth) and 10 families in KwaLanga, Uitenhage, whose homes were ravaged by fire.

The Chair leads a multi-disciplinary Working Group on Human Settlements, with representation of other academic departments such as building science, human settlements, architecture, sociology, construction management, economics, public health and geo-science. This pursues community-based research in selected informal settlements in Nelson Mandela Bay.



Access to water is one of many issues addressed by human settlements planning



Prof Darelle van Greunen and Noxie Otola look at how the Yabelana App works

Centre for Community Technologies

The Centre for Community Technologies (CCT) has grown exponentially since it was formally established in 2014, as shown by the number of internationally funded projects, as well as partnerships. The CCT is involved in research and engagement activities across multiple disciplines and as such is not only doing applied research but also actively implementing interventions that contribute towards the development goals of not only South Africa, but the continent in general.

“The Centre for Community Technologies’ work is focused on the development of human potential and wellbeing, particularly in disadvantaged, vulnerable, and deep-rural communities. Our tool towards achieving this is needs-driven smart technology,” says centre director Professor Darelle van Greunen.

The role of the CCT is to:

- use technology and innovation to contribute to a more prosperous and inclusive society

- accelerate inclusive economic growth
- improve people’s everyday lives.

The CCT engages with community members, particularly in South African townships and rural areas, to co-design technology solutions for everyday challenges, so that technology becomes an enabler in their lives. The CCT integrates transdisciplinary research and innovation with community engagement through the development and implementation of apps and other smart technologies. These in turn enable the advancement of education, health, rural and social development, particularly in low-income communities. This is combined with training, networking, and policy analysis and advice.

The overarching thrust of the CCT’s work is to contribute to the achievement of several Millennium Development Goals for South Africa and the continent, in line with Mandela University’s vision of being a dynamic African university, working in service of society. These goals are to eradicate extreme poverty and hunger,

achieve universal primary education, promote gender equality and empower women, reduce child mortality, improve maternal health, combat HIV/Aids, tuberculosis, diabetes and other diseases, and develop global partnerships for development.

Digital Health Innovations

In the Digital Healthcare Solutions space the CCT studies existing, and designs new, information and communications technology (ICT) that supports health and service delivery in low-income settings. It does this by improving supervision and administration, empowering the health workforce and increasing knowledge at the beneficiary level.

The work currently includes projects touching on electronic health records, health education, clinical decision support and behaviour change support. Working with the entire spectrum of stakeholders directly – including targeted sub-populations (TB patients for example), community healthcare

workers and facility-based healthcare workers – ensures that any new systems designed will strengthen existing healthcare. While ICTs are not a panacea for health systems, they are able to increase knowledge and efficiency for underrepresented populations and overburdened workers.

Ncediso™ App

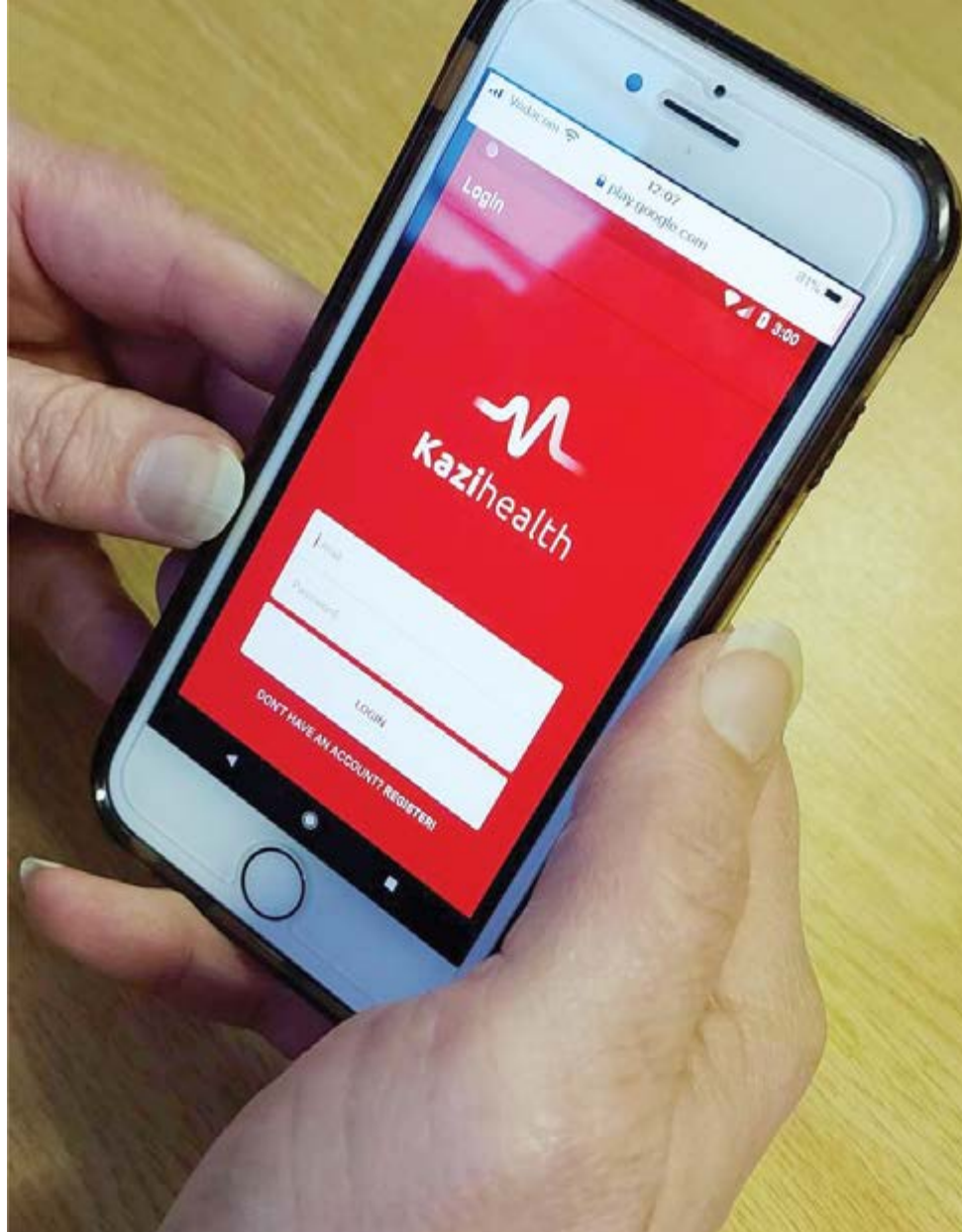
Highlights include the homegrown healthcare app Ncediso™ that ended in the top three and won the top innovation award in the category of High Social Impact at the United Nations Economic Commission for Africa hosted by Zimbabwe in February 2020. The Ncediso™ app is an integrated mobile application developed to upskill community healthcare workers (CHWs) including nurses and clinic practitioners in areas where basic healthcare, first aid skills and clinics are scarce. The application allows for the early detection of various disabilities and diseases among children, child nutrition, chronic disease management, and information on infectious and non-infectious diseases, first aid and various other conditions.

This specific app is unique in the sense that not only is the content adapted for the South African and African context, but all medications and suggested treatments are also aligned to what is available in the African context. All imagery in the app is then also contextualised. The app is available for download in the Google Play Store.

KaziHealth

To demonstrate that Africa has the ability to leapfrog the rest of the world with innovation, the CCT continues to design and develop new digital solutions. This includes KaziHealth, a mobile application developed by the CCT, which received a Merit Award in the fourth Commonwealth Digital Health Awards.

The KaziHealth mobile app integrates three lifestyle interventions, namely physical activity, nutrition and stress management to guide individuals in achieving their personal health goals. Education, motivation and self-monitoring are provided to keep individuals motivated and informed,



and to ultimately make healthier lifestyle choices and decrease health risks.

KaziHealth is part of the bigger KaziBantu project, a specially tailored school-based intervention aimed at consolidating the practice of physical education and ensuring the physical literacy and healthy active living of school children and teachers. The KaziBantu Project is named from the isiXhosa *kazi* – active and *bantu* – people, leading to: KaziBantu – Active People. It is dedicated to creating long-lasting positive health changes in health and opportunities for physical activity, by implementing a multi-faceted approach to address health problems within disadvantaged settings in low- and middle-income countries. The KaziBantu project is an inter-disciplinary project with a consortium of partners, including Mandela University's Department of Human Movement Science, the University of Basel, the Swiss Tropical Disease Unit and the Novartis Foundation.

DigiTB

Over the course of COVID-19 in 2020, the focus increasingly turned to fighting infectious diseases. DigiTB is one solution developed by the CCT to reduce the DS-TB burden through more effective management of disease cases. At present there are no electronic health records in South Africa's public sector to monitor and manage TB patients, even though the latest statistics from Stats SA cite TB as number one on the list of the 10 top causes of death in South Africa. Diabetes comes in at two; three and four are heart diseases; five is HIV/Aids, and six is hypertensive diseases. The development of DigiTB – a mobile application aimed at reducing the drug-sensitive TB burden in the Nelson Mandela Bay Metro through more effective management of disease cases – was initially funded by the Discovery Foundation and thereafter by the Technology Innovation Agency, for scaling and roll-out.

The DigiTB app enables community healthcare workers and general healthcare practitioners to enter each patient's health data into a cell phone, which can be readily accessed. The data recorded includes the patient's name, ID contact details, X-ray reading results, sputum requests or results, kinds of medications used by the patient, contacts they've had, glucose levels (due to the strong TB–diabetes correlation) and what patients ingest.

Biometric recognition supporting Directly Observed Treatment (DOT) ensures adherence to medication. A further enhancement that forms part of the project is the use of Video Observed Treatment (VOT) which allows a healthcare professional to connect in real time to observe the patient taking the medication. This is a further attempt at ensuring compliance. In addition, GeoID and GeoMapping register the GPS location of patients with drug-susceptible TB in the Nelson Mandela Bay Metro, using the built-in GPS capability of the phone; heat maps are then generated to indicate where these patients are moving around in the community and beyond.

With this information, healthcare professionals and healthcare workers can not only manage each patient, they can identify and respond to TB hotspots in the metro, and focus their attention on these to help curb the spread of TB, through health interventions and educational and awareness campaigns.

DigiTB also has a counselling module, which serves as a reference tool during the counselling sessions with TB patients and their families. The Frequently Asked Questions (FAQ) module assists the CHW to answer questions regarding the disease and the TB Medication and Side Effects module provide information on specific medications and their side effects.

Response to the COVID-19 Pandemic

Digital technology has taken centre stage in the fight against the COVID-19 pandemic in 2020 and so too has the work of the CCT. With more than one third of the world in lockdown at one stage, and an urgent need for solutions, the reliance on, and role of, digital technology became more crucial than ever before. Briefly, some of the projects are:

Self-screening assessment BOTS

This easy-to-use tool to check your COVID-19 status is based on guidelines provided by the Department of Health. It is also available in isiXhosa. The BOTS are available at the University website.

COVID-19 Contact Trace and Monitoring Tool

COVTOR, a web-based solution for contact tracing and monitoring, was developed. The solution enables any person who was in contact with a known COVID-19 positive case to monitor themselves for a period of 14 days. The solution allows for key symptoms to be monitored and, should a person present a symptom, he or she will trigger an alert and be advised to present to a testing facility.

CareBuddy

As part of the collaboration between the Office of the Premier and Nelson Mandela University, the CCT partnered with the Eastern Cape Department of Education in developing an electronic screening tool that is interoperable with departmental information systems. The tool is web-based and has a preloaded



Prof Darelle van Greunen shows how to use the Ncediso™ app

database of the more than 5000 schools in the province. Each principal has a unique login for their school in order to do daily COVID-19 screening of learners and educators. It also creates a risk profile of the households where the learners and educators live and uses this to assist in identifying comorbidities and high risk clusters in the different communities.

Yabelana App

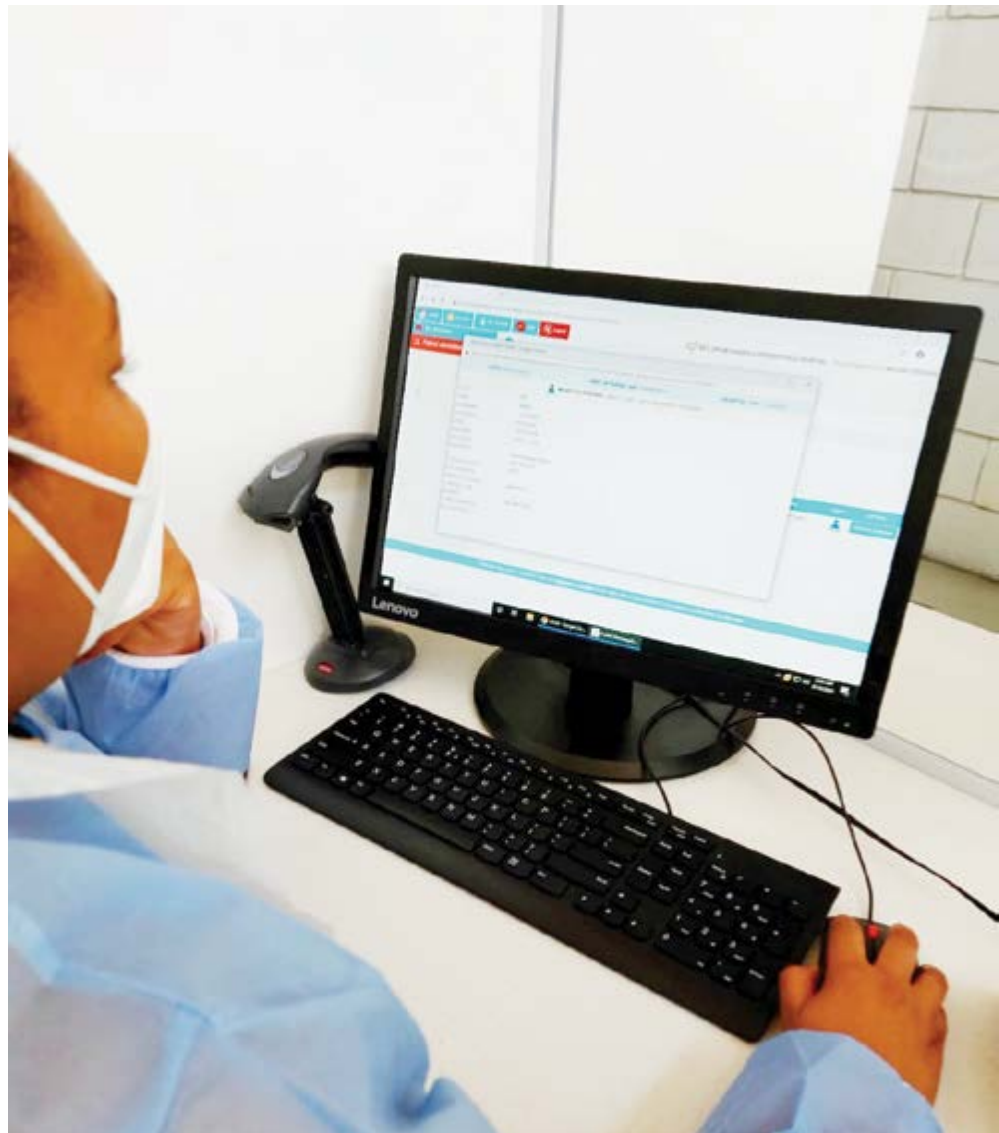
This simple mobile app, originally designed to help older people to access services in some of South Africa's big townships, was rolled out countrywide to allow communities to access information during lockdown. Users can search and find service providers in any category, make contact with them and provide feedback about the service provided. This encourages citizen participation and accountable service delivery.

Yabelana is context specific, and gives a wide range of information ranging from health care and social services to councillors' contacts and events. Prof van Greunen says service providers and citizens can benefit now by putting their services on the app and allowing citizens to see which providers are open and can be of service during lockdown.

"In so doing, it will minimise risk as citizens will know which service providers closest to them are operational. It will also allow them to be in contact with the service providers to establish whether they have what the person is looking for."

Rev Dr Mamisa Chabula-Nxiweni Field Hospital

The new Rev Dr Mamisa Chabula-Nxiweni field hospital in Gqeberha (Port Elizabeth) is the first in the Eastern Cape province. Volkswagen South Africa and the Eastern Cape Department of Health have provided the infrastructure for the first phase of the 1501-bed field hospital. The CCT is responsible for supporting the ICT infrastructure and cloud-based solutions in use in the hospital. What makes this unique is that this is the first and only public sector hospital in the Nelson Mandela Bay area that is completely paperless. Furthermore, it is using a homegrown, cloud-based solution to support each step of the medical journey, from home to hospital, through to discharge and follow-up.



Gqeberha's (Port Elizabeth) field hospital uses a cloud-based hospital management solution

The provincial Department of Health's IT department developed the health management system (HMS), known as HMS² and Mr Anton Strydom, Senior IT Manager, who is enrolled for his master's degree in Information Technology at Nelson Mandela University, is one of the key drivers in its rollout. The solution is also in use at Frere Hospital in East London. It is showing how ICT services do have an impact on the end-user.

Because the facility is WiFi enabled, staff from the CEO to the caregivers use a cloud-based solution to capture patient details, order meals, issue scripts, order x-rays, capture patient care notes, clinical notes and more. These solutions are having a practical impact on how those in the frontline are caring for their patients, in effect, enabling care from the cloud. Staff can access real-time data to report

CCT was leading the digital charge as part of the University's response to the pandemic, in partnership with the metro and province.

and update much-needed statistics on the disease.

Partnerships and Capacity Development

As the footprint of the CCT is enhanced not only in South Africa but in Africa and internationally, more partnerships are formed and a number of successful grant funding applications have been made. It is important to note that the approach to funding grants and partnerships is to ensure that the primary focus of initiatives supports the National Development Goals of South Africa, the research themes of Nelson Mandela University and finally, that all initiatives remain needs-driven.

Human capacity development is shown both by graduates as well as community interventions. The past 24 months have produced seven postgraduates (three PhDs and four master's). A total of 2020 community healthcare workers as well as healthcare professionals were trained in the use of digital technologies. In addition, some 200 learners participated in the weekly "Learn to Code" initiative offered at schools in the northern areas of Gqeberha (Port Elizabeth).

Capacity development was also enhanced at Nelson Mandela University, which is empowering non-office-bound staff with digital mobile devices. About 900 staff benefited from this initiative to improve efficiency and increase productivity.

Through the training offered by the CCT, staff who until then had no, or limited, access to the institution's communication platforms can now access e-mail and the Internet, and use technology to support their daily tasks.

Preparing for eReadiness of Schools

E-schools are the future, but are traditional South African schools ready for it? To evaluate and assess the e-readiness of all South African government schools, the CCT developed an easy downloadable app, called the e-Ready ICT Maturity Assessment Tool.

The app is an initiative of the Department of Science and Innovation and the

The advertisement features the COVTOOR logo at the top, which includes a magnifying glass icon over the letter 'O'. Below the logo is an illustration of a female healthcare worker in a white lab coat holding a clipboard, standing next to a male individual in a yellow shirt. The background is a green gradient with a white circular shape behind the characters. The text below the illustration reads: "A COVID-19 monitoring tool. If you have come into contact with a known COVID-19 positive person or a suspected positive person, you are requested to use this tool to monitor whether you develop any symptoms." At the bottom, there are two yellow buttons labeled "Get Started" and "Login".

Technology Innovation Agency (TIA) with input from the Department of Basic Education.

"Education can only be accessible to everyone if we enable access to education and learning through technology, and make it affordable. The need for e-readiness has been highlighted by the COVID-19 pandemic with people realising that learning should take place wherever students find themselves," says Prof Van Greunen.

"If the Fourth Industrial Revolution (4IR) is to deliver on the promise of economic growth, job creation through innovation, improved safety and security, better education and skills transfer, South Africa has to rapidly and immediately change its education focus and delivery model to be ICT-responsive and e-ready," she notes.

Find-My-Mojo

The Find-My-Mojo app is a mobile app developed to help individuals manage

their emotions and to improve the lives of those living with mental issues. Whether it's depression, anxiety, stress from work, family, relationships, student life, or other conditions, Find-My-Mojo helps individuals to assess their personal wellness. They can seek immediate assistance in the event of a crisis or if they need to talk to someone via the app's quick link to 24/7 support services. It is available for download in the Google Play Store.

Leap Agri

Leap Agri is a project that focuses on the education of farmers with regard to soil and crop monitoring. The project aims to teach and educate farmers about soil and crop management by using sensor data collected via smartphones which will then be sent to the farmers' soil management application via Bluetooth.

The CCT is responsible for developing the Sensor Application and the mobile soil application to be used by the farmers.

Southern Africa Cisco Academy Support Centre

The Southern Africa Cisco Academic Support Centre (SACASC) is a partnership between Nelson Mandela University and Cisco Systems, a networking technologies conglomerate based in the US. Through this partnership, the SACASC renders support and training services to a variety of private and public institutions in education and ICT.

SACASC operates as a unit of the School of ICT where its role is to manage and support Cisco programmes and academies.

For this entity, being “in service of society” means building partnerships, infusing relevant cutting-edge communication networking skills to academic programmes, and imparting computer networking skills both to the marginalised

communities and established IT professionals who implement and support networking systems.

“Our projects are designed to yield social and economic transformation of the national and regional communities we serve,” says SACASC manager Gratitude Kudyachete. “As an entity, we pride ourselves in fortressing the Nelson Mandela University brand in national, regional and international fora afforded by our support and training activities.”

The SACASC is directly and indirectly involved with nearly 300 educational institutions running Cisco Academies in Africa and the Middle East.

A full 11% of the Cisco international programme student population falls within the ambit of the Mandela University entity.

“The programme is not just a theoretical programme,” says Kudyachete. “The content is of a world-class standard and maps to external international certification exams which students may take as an option as well. This once again lends it international recognition.

“The courses, however, also include a practical component, where students get the opportunity to apply the theory learnt on real networking equipment.”

At the virtual Africa Cisco Safari Conference in July 2020, Cisco gave awards to two staff members from the School of IT:

- Shaun Vincent won the Advanced Instructor Award for being one of the top five Cisco Instructors in Africa in 2019. This award is based on student





Uneswa Vice Chancellor Professor Justice Thwala, left, Principal Secretary in the Ministry of ICT Phesheya Dube, centre, and Mandela University's Gratitude Kudyachete at Uneswa's first Cisco Academy graduation in Eswatini

feedback, course completion and experience.

- Gratitude Kudyachete was recognised as a Cisco Hero for giving of his time and running virtual instructor training for the Cisco community during the pandemic lockdown.

Nelson Mandela University's Cisco team won the Top Academy Support Centre Award at the Cisco national conference held in Cape Town 2019.

The award was made for outstanding performance as a Cisco Academy Support Centre in Instructor Training, Student Growth and Academy Support. This is the fourth time it has won the award.

Africa Moves Ahead Initiative

The SACASC partnered with Cisco in 2020 to ensure continuity of the Cisco academy programme over the pandemic. A lot of academies could not attend normal instructor training programmes and it was also necessary to provide support. Instructors were trained free. Specifically, the SACASC trained 24 lecturers in Cybersecurity Operations and another 28 instructors in CCNA (Introduction to Networks).

eSkills Colab

In 2020, the entity partnered with eSkills Colab based at Walter Sisulu University

in East London to train participants from government departments, municipalities and TVET colleges. There were 42 trainees in Introduction to Internet of Things and another 40 in Connecting Things. Another partnership with the eSkills Colab at the University of Mpumalanga led to training a group of 23 lecturers and students, who did the course CCNA (Introduction to Networks). A partnership with Nemisa National Electronic Media Institute of South Africa (Nemisa) and the Eastern Cape eSkills Colab led to training TVET lecturers, IT support professionals in government departments in the Internet of Things and Cybersecurity. A total of 83 trainees benefited from this training in 2019.

Vodacom Youth Project

The entity established the Vodacom Youth Academy to train trainers for disadvantaged youth as well as capacitating IT support staff who work in Vodacom Teacher Resource Centres. So far, 20 instructors have been trained in IT Essentials, CCNA and presentation skills. Hundreds of youths and teachers have started to benefit from this ongoing project in all nine provinces of South Africa.

Other recent projects undertaken include:

- **DHET TVETs:** Partnership between Nelson Mandela University, Cisco Systems and DHET to train TVET

lecturers in the Fourth Industrial Revolution Skills Initiative. A total of 22 lecturers were trained.

- **Uneswa:** Training 12 University of Eswatini lecturers in CCNA 1-4, CCNP, and training 21 security professionals and lecturers in cybersecurity.
- **Zimbabwe:** Running a cybersecurity workshop for lecturers and ICT security professionals in 2019.
- **Cisco Academy Advisory Board:** SACASC is an ongoing participant in this global initiative to shape policy and strategies for the Cisco Academy programme.

Pearson Vue Testing Centre

The Pearson VUE Testing Centre (PTC) at Nelson Mandela University is part of a global network of test centres. This Virtual University Enterprise (VUE) aims to connect people with authorised certification training, and help the IT industry better serve its learners.

Pearson VUE takes the lead in computer-based testing from online practice tests to high-stakes, proctored exams that require the industry's most secure testing environments.

It serves test-owners and test-takers in nearly every industry including academia and admissions, financial and related services, government, health care and information technology.



Infrastructure Development and Engagement Unit

The vision of the Infrastructure Development and Engagement Unit (ID & EU) is to be at the centre of an industrialised continent of Africa, and shine a practical light on infrastructure financing.

Infrastructure development and services globally are central to economic activities such as facilitating trade, economic growth, human development and productivity across many sectors of the economy. The unit is therefore an industry-driven infrastructure development unit, coordinated by an institution of higher learning, to enhance Africa's trade capacity and economic performance through infrastructure investment.

Led by professional associate Bongani Mankewu, the unit engages various stakeholders to this end.

"Infrastructure development is essential for economic growth, community development and productivity. The provision of basic infrastructure such as transport networks, water and sewerage systems enhances communities while at the same time provides employment opportunities," says Mankewu.

"Our goal as the Infrastructure Development and Engagement Unit is to seek to participate in all relevant initiatives within the domestic infrastructure landscape."

The main objectives are to:

- facilitate public private cooperation for infrastructure development
- enhance analysis and development that will augment industrialisation
- facilitate project preparation for bankability in the region.

In addition, it provides a platform for staff and postgraduate students at Nelson Mandela University to engage in infrastructure finance engineering activities with the industry, including engineering procurement construction contracts firms.

Further objectives are to collaborate strategically with development finance institutions, international finance corporations and other multilateral institutions, including regional economic communities, for project development that aligns with industry standards.

The unit also aims to influence how infrastructure projects are structured so as to sustain both greenfield and brownfield phases.

Cross Laminated Timber Engagement Unit

A University Faculty in the service of society is one where structures such as research or engagement entities, academic staff and researchers collaborate with industry and or government partners to solve specific challenges facing society or government through research and innovation.

The Cross Laminated Timber Engagement Unit (CLTEU) is intended to play a pivotal role in this, explains unit head Dr Oswald Franks. Specifically, it aims to contribute to developing prospective opportunities and a future roadmap at a strategic level to shape the future of the

timber construction industry in South and southern Africa.

As a university in service to society, Mandela University seeks to provide practical solutions to socio-economic challenges in South Africa which are grounded in rigorous research. The institution recognises the need for strong, sustainable building materials that address the challenges of the need for durable structures. This is particularly so in relation to the provision of sustainable housing solutions for South Africans who have not had access to alternative building materials that contribute to reducing carbon emissions, and enhance sustainability of the natural environment.

“The future of engineering and the built environment in South Africa lies in endeavouring to mainstream sustainable building materials,” says Dr Franks.

“One wants to make the environment, and the planet, available to future generations and the onus is on us to ensure that we engage in activities that minimise or eliminate carbon emissions.”

Cross Laminate Timber (CLT) is an alternative, manufactured timber, and a new building material that contributes significantly lower carbon emissions, compared to conventional concrete and steel. Hence it is a more sustainable





West view of the George campus CLT building design

and environmentally friendly building material.

“CLT is a sustainable building product that can help mitigate climate change,” Dr Franks says.

As such, the CLTEU is working to promote:

- adoption of CLT as an alternative building material
- inclusion of CLT in the curriculum of existing programmes
- development of short learning programmes for reskilling practitioners such as structural engineers, architects, construction managers, and quantity surveyors
- CLT research to better understand its characteristics and applications in the South African context, where there will be unique challenges
- the establishment of a CLT ecosystem to support and contribute to the eventual establishment of a CLT manufacturing industry in South Africa – with the associated triple benefits of economic growth, job creation, and poverty reduction.

CLT in action on George campus

Dr Franks cites, as an example of invaluable green contribution through this new technology, the University's CLT building under construction on the George campus.

Mandela University partnered with a start-up Italian firm, Innovhousing, to design and build the iconic CLT demonstration building for the George campus. Innovhousing was able to enlist support and contributions from Alessandro Zuanni and wood structural engineer Franco Piva – both of whom have prior CLT experience – and who have designed the iconic two-storey, 350sqm, multi-use CLT demonstration building for the campus.

Once constructed, it will showcase CLT's potential, flexibility and aesthetics. It will also serve as a natural incubator that brings together university and public life through the complementary functions in its versatile, connected, open-plan design.

Construction work was due to have started in 2020 but the COVID-19 pandemic delayed construction and the projected date to break ground is now around April 2021.

“While we are importing the customised CNC-cut CLT panels from Europe for this build, we aspire, in the medium to longer term, to see a fully-fledged CLT industry established in the southern Cape where there are all the elements for a CLT industry and value chain,” explains Dr Franks.

Although there are a few other CLT buildings in South Africa, this is one of the first of its kind.

“Buildings constructed using CLT require minimal heating and cooling, therefore further reducing the carbon footprint of a building,” says Dr Franks.

“The conventional construction industry contributes about 10-15% of all carbon emissions globally, so reducing the contribution from conventional construction methods and material in and of itself creates a more sustainable planet for the years to come.”

Maritime Training Centre

The Nelson Mandela University Maritime Training Centre in partnership with STC-SA offers Maritime Training and Marine Engineering High Voltage Training at its facility on the North Campus, Gqeberha (Port Elizabeth).

It offers Maritime and Basic Safety Training learning opportunities in accordance with the Standards of Training, Certification and Watchkeeping for Seafarers (STCW), as amended in 2010 and the South African Maritime Safety Authority (SAMSA) Qualifications Code.

The training centre was designed specifically to meet the growing demands of the transport, logistic and maritime industries while bridging the current gap in the market, ensuring that standards are maintained and that knowledge migration is imparted to the sub-sahara region of Africa.

The Maritime Training Centre also forms part of the Wärtsilä Land and Sea Academy (WLSA) and plans to provide high-quality training services to the marine market with the marine equipment donated by Finnish company Wärtsilä.

All learning opportunities presented at the Training Centre conform to international requirements and are regularly reviewed to meet the ever-changing demands of the maritime industry. The goal is to provide jobseekers with the certification and skills required to join the ever growing industry, as well as to meet the needs of related industries throughout Southern Africa.

The Maritime Training Centre falls under the AMTC entity. Its short learning programmes range from two to 10 days, and are offered in groups of between 10 to 25 delegates.

Courses include:

- Medical First Aid (including Elementary First Aid)
- Elementary First Aid
- Pre-Sea Safety Familiarisation Training
- Personal Safety with Social Responsibilities
- Personal Survival Techniques
- Competence in Security Awareness
- Designated Security Duties
- Marine High Voltage Safety.

In 2019, its first year after receiving accreditation from SAMSA, the centre trained more than 80 delegates between February and September.

Complying with University protocols during COVID-19 in 2020 limited the centre to only being able to run two courses, with 15 delegates, but it hopes to increase this again in 2021.



The Maritime Training Centre presents short learning courses to meet the demands of the maritime industry



Ocean gliders are used to survey and gather data from the oceans

Marine Robotics Unit

Nelson Mandela University established the Marine Robotics Unit in March 2019 to support researchers on the new Ocean Science Campus as well as other activities needing support and expertise in the field of marine robotics.

Marine Robotics encompasses all the engineering disciplines and provides the opportunity for students and engineers to contribute to the blue economy by enabling the sustainable management of natural resources through advanced automation, communication and sensor technologies.

Although the new unit is based in the Faculty of Engineering, the Built Environment and Technology (EBET) it follows a multi-disciplinary approach, given the transdisciplinary nature of its

“Initially, the unit will support research in the Western Indian Ocean through the deployment and operation of off-the-shelf existing robotics ...”

work. Director of Engineering at eNtsa, Andrew Young, is responsible for the Marine Robotics Unit as it moves into 2021.

Initially, the unit will support research in the Western Indian Ocean through the deployment and operation of off-the-shelf existing robotics such as autonomous underwater vehicles and gliders. The unit will host and maintain this equipment with dedicated Nelson Mandela University engineers and scientists who will also manage data collection missions.

The second function is to stimulate innovation in marine robotics, that is, to design and build new robots to support the ocean sciences, which may also include the development of sensors and systems.

Third, the unit aims to create a strong training component for undergraduate

“Although the new unit is based in the Faculty of Engineering, the Built Environment and Technology (EBET) it follows a multi-disciplinary approach ... ”

and postgraduate students from Western Indian Ocean, regional and northern hemisphere institutions.

Furthermore, the Marine Robotics Unit will:

- provide opportunities for staff and postgraduate students to collaborate with Nelson Mandela University's researchers to make products and technical equipment in support of the ocean scientists and related researchers
- help formulate a strategy for technology and human resources development at the University
- solicit funding for its activities and

build “innovation bridges” between northern hemisphere and African Centres of Excellence

- lend engineering support and provide training to researchers using existing marine robotics platforms
- engage in developing new solutions to challenges facing ocean scientists
- provide innovation, research and development opportunities for students wanting to pursue further studies.

South African International Maritime Institute (SAIMI) funding

The Marine Robotics Unit was fortunate to secure funding through the South African International Maritime Institute (SAIMI) to establish activities within the unit. The funding will speed up the progress of activities already envisaged, such as developing assets as well as communication, tracking and sensor technologies. The partnership with SAIMI will help to establish the unit as a centre for leading research into marine robotics platforms. It also will contribute to human capacity development, as well as provide consulting services to industry, government and the scientific community.

Projects identified include:

- development of a wireless charging system for autonomous vessels at sea
- haptic feedback technology for sensors and control systems
- autonomous solar- and diesel-powered surface vessels
- communication technologies for long-range data transfer: RF, Beamforming, Sonar
- capstone projects for undergraduate students.

Collaborations are being explored with UCT, CPUT and TUT in South Africa, Montpellier and Gustave Eiffel in France, Plymouth University (UK) and NTNU (Norway).



Marine Robotics provides the opportunity for students and engineers to contribute to the blue economy

Centre for Research in Information and Cyber Security

The Centre for Research in Information and Cyber Security (CRICS) aims to address all types of activities that can assist in enhancing information and cyber security in general.

"In the Centre for Research in Information and Cyber Security (CRICS), we are engaged through researching relevant, real-life problems, and by connecting to communities through professional and community activities," explains centre director Prof Reinhardt Botha.

CRICS does extensive work regarding information and cyber security

awareness, training and education with the aim of fostering an information security culture in organisations.

"There are a lot of people who got a technology culture shock this year," says Prof Botha of how the COVID-19 pandemic of 2020 has pushed more people online than ever before, bringing with it an increased awareness of cyber security.

However, he says, the work done by CRICS has been steadily growing since it first germinated in 1990 at the former PE Technikon. That means that today it is well placed to be in service to a society which

is increasingly reliant on the internet – and facing online threats. Such as, for example, conducting research on how to use artificial intelligence techniques to detect malware or ransomware, or how to identify fake news.

The eight members of CRICS are actively involved in national and international professional bodies and share their findings and insights through extensive academic publishing and conference presentations.

CRICS members are active in the International Federation of Information Processing (IFIP), specifically in the





Professors Reinhardt Botha, right, and Mariana Gerber received the 2019 ISACA Contribution Award on behalf of CRICS with Jarell Toi, ISACA SA Board Member

working groups of Technical Committee 11 (TC11).

The centre also engages domestically with other industry bodies such as the Institute of Information Technology Professionals South Africa (IITPSA), and ISACA (previously known as the Information Systems Audit and Control Association) through organising industry events.

ISACA awarded CRICS the ISACA Contribution Award in 2019, which Prof Mariana Gerber and Prof Reinhardt Botha accepted on behalf of the centre.

The Contribution Award is made to an individual or organisation that has made a solid and significant contribution to research, education, publications, or other developments and activities in the field of Information Security risk management, audit and assurance, governance, security and cybersecurity.

This accolade also focuses on other aspects of the work done at CRICS, namely teaching, developing and preparing students and graduates for the world of work. A large part of the focus at CRICS has an academic and research inclination, as seen by its list of academic publications.

“ ... we are engaged through researching relevant, real-life problems, and by connecting to communities through professional and community activities ... ”

This can be seen in outputs which in 2019 included seven journal and five conference papers, five master’s graduates and one PhD graduate. The centre’s outputs in 2020 included five journal and two conference papers, as well as postgraduates in April and December. CRICS members supervised four PhD, five MIT and one MPhil candidates, and

there were also eight MPhil and one MIT graduates in CRICS-related topics.

Although primarily a research entity, CRICS is increasingly involved in supporting qualifications in IT governance and security and so it collaborates not only within the Faculty of EBET’s Department of IT management and corporate governance, but also with the Faculties of Law, and of Business and Economic Sciences, to co-ordinate course content.

In 2020 CRICS members personally shone as follows:

- Prof Lynn Futcher was nominated as an IFIP TC11 Category “C” member at the 2020 IFIP TC-11 AGM.
- Prof Rossouw von Solms received an NRF B2-rating for 2021 – 2025.
- Prof Reinhardt Botha was appointed to the Computer & Security journal’s prestigious Editorial Board.
- Prof von Solms received an Emerald Literati Award for a paper entitled “How does Intellectual Capital Align with Cyber Security?” co-authored with Profs Basie von Solms (UJ) and Karen Renaud (Abertay).
- Prof Kerry-Lynn Thomson continues to serve as the IFIP 11.12 WG Chair – Human Aspects of Information Security and Assurance.

Fulfilling another part of being in service of society, CRICS members also presented cybersecurity talks at a STEM workshop, schools, a careers evening and the FamHealth Leadership Academy.





Built Environment Research Centre

A built environment in the service of society aims to do more with less, using technology as an additional tool to achieve this.

Built Environment Research Centre (BERC) interim director Chris Allen, head of the Department of Construction Management, said the centre has a strong research focus, with its primary purpose to:

- identify new built environment research areas and develop new materials
- contribute to research and take advantage of research opportunities within the commercial built environment sector

- facilitate knowledge transfer to and from the built environment professionals through research enterprise.

Based in the School of the Built Environment and Civil Engineering on the North Campus of the University, BERC conducts cross-faculty, cutting-edge, built environment industry-originated research. It also facilitates the learning of industry sponsored MSc and PhD candidates, and engages in extensive collaboration with other research institutes regionally, nationally and internationally.

Research focus areas include 3D printing, materials science, drones, robotics, digital construction including building

information modelling (BIM), smart and net-zero carbon buildings as well as Industry 4.0 implications for health and safety, and occupational health within the construction sector.

“By employing smart sensors in building equipment or civil engineering infrastructure we can optimise performance, reducing carbon emissions and extend maintenance cycles,” says Allen.

“Likewise, the very materials used can be teched to be stronger, lighter, cheaper and perform better in our changing climatic environment, thereby reducing raw material use and enabling new

“By employing smart sensors in building equipment or civil engineering infrastructure we can optimise performance ... ”

manufacturing processes such as 3D printing to be employed commercially.”

The COVID-19 hit year of 2020 also shone the spotlight on other areas of research.

“Indoor air quality and ventilation may profoundly impact the spread of diseases in our built environment and therefore there has been much discussion concerning the importance of this in our buildings,” says Allen.

“Mandela University has a core focus on building safety, with indoor air quality hugely important for the air we breathe within our built environment.”

BERC research areas therefore currently include the role of poor air quality and viral spread, as well as the maintenance of social distancing, both of which are relevant to venue capacity design and facilities management.

In addition, research is addressing lean construction and the improvement in human settlements, including research on waste management and smart cities. A focus on property development and the economics of the built environment in an African context are areas the centre is to pursue further.

Furthermore, BERC looks at how the business of construction can be streamlined through digital technologies that:



- enhance the communication process
- enable mistakes to be made virtually first
- provide a digital twin of the final product to be accessed virtually for the lifespan of the building.

This then enhances the management of those buildings through data analysis and artificial intelligence, closing the loop by providing further feedback to improve the built environment for future generations.

Advanced Engineering Design Group

The Touch Hand prosthesis is undergoing continual development



mechatronics and electronic/electrical engineering.

“These are not random engineering projects which may not go anywhere; they are geared for the real world,” explains Hands of the projects on which the students volunteer to work.

The group thus focuses on collaborative projects to get physical and functional outcomes that promote and encourage engineering design, using the latest technology in tandem with industry and private sector partners.

Together they tackle projects that focus on Design for Lightweighting, Design for Additive Manufacturing (DfAM), Generative Design, Biomimicry and Conceptual Design, and Industry 4.0 Design Integration.

When faced with the challenges of COVID-19 in 2020 they immediately started to cater for urgent needs in the medical community, supplying desperately needed personal protective equipment as well as in-theatre and in-ICU devices to Livingstone Hospital in Gqeberha (Port Elizabeth).

“These projects were born out of the local government hospitals battling to get equipment, as the pandemic has been dire in the Eastern Cape,” said Hands, adding that AEDG would continue to look for projects with a medical orientation.

“The group has also developed significant ties with the Nelson Mandela University Medical School over the last

few months,” he said. The new school, only the second in the Eastern Cape, is due to open in March 2021.

In general, AEDG projects focus on challenges that are student-driven. They also focus on those which cross-institutional, industry and private sector participation and collaboration to produce multi-disciplinary physical and functional outcomes. The goal is to promote and encourage engineering design using the latest available design and analysis technology.

This has led to a global network of expert individuals and companies who are contributing and collaborating with the group on these projects in their own specific areas of expertise.

There have been several project highlights at AEDG, of which the following are a sample.

Intubation Unit and accessories

The Intubation Unit Project has been a resounding success in its aim to help protect health-care workers on the frontline of fighting the COVID-19 pandemic, and who rely heavily on personal protective equipment.

Students in the AEDG, together with Gqeberha (Port Elizabeth) companies Custom Works and Shibah Engineering – whose director Cecil Frost is also a Mandela Uni Mech Eng alumnus – designed an intubation box or “hood” to reduce the aerosolised droplets generated by patients during the intubation procedure. By stopping the droplets from patients potentially infected with the COVID-19 virus from

Although the Advanced Engineering Design Group (AEDG) is continuously working on projects in service of society, in 2020 it proved it also can do this quickly by developing health-care products such as a ventilator and an intubation unit and accessories in the first weeks of the COVID-19 pandemic.

Students also successfully worked on Touch Hand and Touch Hand Socket projects, both of which have immense potential to benefit the lives of amputees.

Mechanical engineering academics Clive Hands, who is AEDG project manager, and Dr William Rall make up this engagement entity which guides students from mechanical engineering,

becoming airborne, it shields the medical staff in theatre during the procedure.

Although multiple contributors from a network of academic and private sector experts contributed to the project, Hands is immensely proud of the young team who put the first prototype together in less than a week at the start of South Africa's national lockdown in April 2020.

The students encountered numerous challenges to building the proposed unit, so the design process was preceded by strategies to tackle these hurdles at each stage of development. One of the most important steps required before the hospitals could use the hood was getting it registered by the SA Health Products Regulatory Authority, and the process was frustratingly slow.



Student Zaahid Imran was a key part of the team which designed, built and tested the intubation unit over COVID-19

Additional smaller jobs also arose, such as 3D prints of an adapter for the vacuum extractor, suction waste collector connectors, and an extraction cover for a surgical saw device for both neurosurgery and orthopaedic processes.

The resultant Airway Manipulating Aerosol Extraction Hood is thought to be the first unit of its kind in the world and there are now plans to roll out 50 000 units to medical facilities across South Africa. The intubation box is not only

useful against COVID-19, but can be used with patients suffering from another of South Africa's serious health challenges, namely tuberculosis.

Salutaris Ventilator

The Salutaris Ventilator Project was another rapid response to COVID-19 in 2020. A student-run start-up, Hedge-SA, took the initiative to join the Emergency Ventilator Response Team, a consortium formed to provide solutions in response to the pandemic. The first mission was to create a low cost, easy-to-manufacture, automated resuscitator to help meet the growing demands of the coronavirus ventilator shortage.

The new ventilator targets pre-ICU patients with breathing difficulties and is named "Salutaris", which is Latin for health-giving. The initial conceptual design was derived from MIT's open-source E-vent emergency ventilator.

The project is now far down the road towards finalising the development of a ventilator that is a level above that of CPAP machines, to which the National Ventilator programme (NVP) subscribes.

The current Salutaris design is a non-invasive ventilator, but there is a new call by the NVP for an invasive ventilator. Given where Salutaris currently is, there is significant scope to get it to the more advanced invasive ventilator stage via several levels of sophistication in respect of research and development.

Thanks to funding from merSETA, preparations for this second major phase are now underway. This will enable the AEDG to further support the Hedge SA team to develop this truly South African product, which can be manufactured for both local and international use wherever needed.

Touch Hand Project

The group is involved in the further development of the Touch Hand prosthetic device, in tandem with Stopforth Robotics, Axiology Labs, Rapid3D and Custom Works – this is a cheaper locally made prosthetic aimed at a local market based on a modular tier-affordability outcome.

AEDG is in a multi-staged development programme which saw a South African team compete in the prestigious international Cybathlon event in November 2020. This involved integrated multi-disciplinary disciplines integrating a custom-designed hand and socket with in-built sensors enabling the amputee pilot to complete multiple tasks. Due to COVID-19, the event was held virtually.

Although part of the Touch Hand Project, the Touch Hand Socket became an independent project. This involved creating a wrist cup, wrist and elbow glove and the socket itself, both as a composite and as a 3D-printed option. The 3D-printed socket was inspired by a number of similar latticed braces out on the internet. The intention was to create



The Hedge student team of Kelvin Langwani, Neo Mabunda and brothers Zain and Zaahid Imran with the Salutaris ventilator

an integrated latticed socket into the current collar designs which would be aesthetically extremely cool but, more importantly, provide breathability for the lower forearm limb as well as being a one-piece device.

Additional challenges were that, due to the national lockdown over several months, the entire project had to be completed with the team working remotely from each other.

SCARA Robot Project

This remarkable project was a final year Mechatronics Design Project in 2019. It involved the design and integration of a custom-designed four degrees of freedom (4-DOF) selective compliance assembly robot arm (SCARA) robot to integrate with the current desktop CNC installation in the Mechatronics Lab (M013).

The SCARA is designed to interface with a current computer numerical control (CNC) machine. It handles the material in and out of the assembly cell based on a Machine Vision system, which is also part of the project. The SCARA is also required to use the current human-machine interface (HMI) to display web-based monitoring and Internet of Things (IoT) control capabilities.



The Eco-Car Project has been a multi-disciplinary project over several years

It used multi-disciplinary skill-sets integrating all the above focus areas together with topology optimisation design strategies to create the lightweight consolidated arms with internal ducting. It also featured a unique compliant gripper, printed in one piece, reducing down from 17 parts. The robot was displayed at

multiple expos and technical conferences and also featured in a number of global online webinars.

MTB Frame Design Project

This project was carried out in conjunction with a BTech Design Project, and involved the design of a bespoke mountain bike frame (MTB) intended for production by metal additive manufacturing (AM) as a single piece output. The project involved:

- spec'ing the mountain bike in respect of applicable load cases according to internationally accepted standards
- carrying out dynamic analyses to isolate critical load cases
- establishing an overview layout
- applying generative design techniques using topology optimisation to achieve as lightweight a structure as possible.

This would then be produced via metal AM printers and then, ideally, tested by both microCT and digital image correlation techniques to establish and verify load cases.

The 3D printed structure has been shown at four international industry events, and was selected as a finalist in



The SCARA robot project was a final year Mechatronics Design Project in 2019

the Purmundus Challenge at the largest Additive Manufacturing trade show in the world, FormNext, in Frankfurt, Germany. After competitive judging, the design went on to win the Public Choice.

This project was the only design at FormNext which was a solely student project not related to research. Most of the other entrants to the competition were commercial entities.

This was a major accolade for the team, who did an outstanding job in the design.

Eco-Car Project

The Eco-Car Project has been an exciting multi-disciplinary project over several years that focuses primarily on the design, development and manufacture of an ultra-lightweight vehicle with the specific intention of attaining the greatest possible distance from the lowest use of fuel.

This entailed design for light-weighting, enhanced telemetry strategies and multiple associated projects involving external industry and academic partners.

The Eco-Car Team was able to win and set multiple records in the Shell South African Eco-Marathon for three successive years. Although lack of sponsorship put this project on hold in 2019, and COVID-19 put it on the back burner in 2020, the

group hopes to continue with this project in 2021.

Carbon Wheel Optimisation Project

This unique project saw the design and optimisation of a bespoke carbon composite wheel for use in the Eco-Car. It also led to a master's research degree that was nominated for an award in the 2018 National Advanced Manufacturing Innovations Awards.

This research, which placed the team at the forefront of this evolving and cutting-edge design approach in this country, led to the University being awarded the Altair software suite as well as an additional sponsorship. The work was also presented at the prestigious international Altair Technical Conference in Frankenthal, Germany alongside top OEM industry representatives from Airbus, Mercedes, VWAG, Porsche and others.

It also won the Three Minute Thesis Competition, an innovative Mandela University forum, in the category Science, Engineering and Technology Master's Degrees against competition from many other Faculties. The carbon wheels were installed onto the Eco-Car and were on the vehicle for two of the championship winning events, where they performed flawlessly.

C-Bracket Project

This deceptively simple little bracket stemmed from a collaboration between the AEDG, Altair SA and the MicroCT Scanning Unit at Stellenbosch University. It involved the use of topology optimisation and extreme lightweighting design techniques to produce a metal titanium 3D-Printed component.

This was not only used in a round-robin test across multiple metal-AM printing bureaus to gauge comparative quality and 3D printing standards, but also installed on the Eco-Car and carried the entire front end of the vehicle, despite being just over 40g in mass.

The work done with this little bracket led to multiple presentations at both local and international technical conferences, as well as a research paper and magazine articles.

Rear Drive Supports Project

This project saw the group make its first foray into lattice design in respect of lightweighting, and the curious resultant components looked very different to any traditional subtractively manufactured component. They were printed in titanium via metal-3D printing via the Centre for Rapid Prototyping and Manufacturing at the Central University of Technology in Bloemfontein in tandem with the MicroCT Scanning Centre and were then installed into the Eco-Car for competition.

To date, they have performed without any issues whatsoever for several years. Again, the work done here was presented at multiple conferences and expos.

All previous AEDG completed projects from 2018, 2019 and 2020 not presented above can be viewed on the group website at aedg.mandela.ac.za. These include:

- Steering Arch project
- Steering Wheel project
- Brake Support Structure project
- eDrive project
- IoT & AI project
- AM Golf Club project.



This bespoke mountain bike frame was a BTech Design Project in the AEDG entity

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