

ScienceScope

SHOULDER TO SHOULDER WITH SMMEs

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BET ON THE BIO-MANUFACTURERS

Drain-cleaner bugs, mushroom proteins and probiotics – products ready for the bioeconomy

FIREFIGHTER DRONES

Local drone company deploys CSIR fire-detection sensor

CANNABIS COSMETICS

Body butters and other products that meet regulations



science, technology
& innovation

Department:
Science, Technology and Innovation
REPUBLIC OF SOUTH AFRICA



▶ DON'T MISS THESE VIDEO STORIES!



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Vegan protein powder for food companies

The CSIR has developed a mycoprotein product for local SMME MycoSure, which can be added to soups, shakes and other foods. The starting material for MycoSure's mycoprotein is *Fusarium venenatum*, a fungus known to have a high protein content.



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Scientific support for South African cannabis products

Local cannabis cosmetic business Green House Village is one of 23 SMMEs that the CSIR has supported with the development of high-quality, regulatory-compliant, safe, efficacious and affordable cannabis products for local and international markets. The CSIR assisted SMMEs to develop over 40 cannabidiol-infused and cannabis-based prototypes from hemp and dagga raw material, including nutraceuticals, cosmeceuticals and herbal remedies.



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A new defensive pod technology for fast jets

In March 2024, a South African Air Force fast jet took to the skies near Cape Agulhas, carrying a new, locally developed technology that could help aircraft defend against attacks. These flight tests were the culmination of work that began when Armscor tasked the CSIR in 2019 to assist local small business Sysdel CC with integrating its new pod with the Hawk aircraft.



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Western Cape firefighter drones to use CSIR sensors

Table Mountain authorities in the Western Cape may soon call on firefighter drones to detect and extinguish small fires in hard-to-reach places before they spread to the City of Cape Town. In March 2024, the CSIR exclusively licensed its K-Line fire sensor to a local company, Autonosky, which designed their Autono1 drone to drop fire-retardant balls on small-scale blazes.

ENQUIRIES

enquiries@csir.co.za
+27 (0) 12 841 2911
www.csir.co.za

COMPILED BY

CSIR Communication
CSIRComms@csir.co.za

DESIGN AND PRODUCTION

EPICreative
www.epicreative.co.za

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FOREWORD

Small, medium and micro enterprises (SMMEs) make a vital contribution to economies in both developed and developing countries.

Expert sources concur that these engines of economic growth globally account for more than 90% of businesses, between 60 and 70% of jobs and more than half of GDP. In South Africa, the Department of Small Business Development in 2023 estimated SMME employment at 87% and GDP contribution at 40%.

This special issue of *ScienceScope* showcases how the CSIR supports and collaborates with microenterprises and other small-to-medium businesses, in line with the national imperative to grow the South African economy and advance its technological competitiveness and skills. The CSIR strategy prioritises the creation and growth of new enterprises while enhancing the competitiveness of existing ones. In the 2023/24 financial year, the CSIR supported approximately 179 SMMEs, with 69% of these being at least 50% black owned, 20% with youth ownership more than 50% and 30% at least 50% women

owned. The CSIR also provided access to its niche technology base through several licence agreements. Of the licence agreements concluded in the last year, 62% were issued to 100% black-owned companies and 15% to women-owned companies.

In this edition, a fraction of our support is highlighted. In some cases, support and joint development take the form of access to specialised technical infrastructure and expertise across multiple domains ranging from biomanufacturing to aerospace, and in others, we offer support for regulatory compliance, as is the case in the medical device manufacturing sector. We also assist SMMEs in implementing alternative energy solutions to aid their sustainability and support others' involvement in the local manufacturing of components. We partner with SMMEs to develop novel systems and products, commercialise our innovations and inventions, access new markets and grow human capital in niche fields such as cybersecurity and ocean robotics.

We are resolute about our commitment to our stakeholders in government, the private sector and the international community who continue to support SMMEs nationwide by funding access to CSIR infrastructure and expertise.

Dr Thulani Dlamini
CSIR Chief Executive Officer

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ON THE COVER

The CSIR collaborates with small, medium and micro enterprises to grow the South African economy. Baile Vavi Sexwale (centre) of Green House Village, a producer of cannabis-based cosmetics, is one of 23 SMMEs that the CSIR has supported with the development of regulatory-compliant, safe and efficacious cannabis products. CSIR principal scientist Dr Ghaneshree Moonsamy (left) supports SMMEs by drawing on her extensive experience in biomanufacturing, while the skills of CSIR senior engineer Edwin Magidimisha (right) in sensor technology led to his collaboration with a local enterprise specialising in aerial technology.



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BET ON THE BIOMANUFACTURERS

Whether it's drain-cleaner bugs, mushroom proteins or home-grown probiotics, the entrepreneur is just as crucial to a burgeoning biomanufacturing business as the product. This is what researchers at the CSIR Biomanufacturing Industry Development Centre (BIDC) have learnt through helping 41 businesses develop 124 novel food, cosmetic, cleaning and healthcare products since 2013.

SCAN TO WATCH THE
VIDEO STORY





Lindelwa Shongwe operates a bioreactor as part of his training as a Youth Employment Service intern at the CSIR. Shongwe will join local SMME MycoSure when the enterprise is ready to set up its own facility producing a vegan protein product made from fungi.

The classic start-up phrase “bet on the jockey, not the horse” has certainly rung true for Lara Kotzé-Jacobs, who has been involved with the BIDC since it was first conceptualised over a decade ago. The BIDC has been funded by the Jobs Fund, the Department of Science, Technology and Innovation (DSTI) and the Technology Innovation Agency through the years.

“Our focus is on biotechnology, bioprocessing and biomanufacturing,” she says. “Because it is a developing sector, many people come to us at the concept stage of their business. If we believe that we can add value, the entrepreneurs are strong and that they can get access to other funding and support, we will take on the project and get them to a minimum viable product.”

Kotzé-Jacobs explains that the BIDC puts out formal calls for businesses that need help with research and development. “They’ll outline their idea or concept and at which stage it is currently at, and then we will evaluate it with our advisory panel and steering committee,” she says.

The BIDC then works alongside selected businesses to develop their product or process.

“We won’t develop something that there isn’t a market for,” says Kotzé-Jacobs, adding that entrepreneurs usually understand their market the best.

She says the BIDC has followed this process with 41 businesses and counting, and 29 products have been licensed so far. Some of the most successful BIDC-affiliated companies are MycoSure, ReSyn Biosciences, Capebio™SA, OptimusBio and Lighthouse Healthcare (all registered as propriety limited companies).

While technology development was critical for each of these businesses, Kotzé-Jacobs says it was only one piece of the puzzle. “We make a contribution, but ultimately, it is the entrepreneur who makes it work because they have to go and leverage so many other things, from market access to more funding.”

Nevertheless, the success rate of businesses supported by the BIDC has had an impact, so the model is now also being applied by the CSIR’s biocatalysis and biorefinery industry development initiatives. Learnings from the BIDC helped guide the conceptualisation of the Industrial Biocatalysis Hub under CSIR chief researcher Dr Lucia Steenkamp, as well as the Biorefinery Industry Development Facility under CSIR principal researcher Dr Viren Chunilal.

Kotzé-Jacobs says the support model is attractive to start-ups and established businesses because they can tap into the CSIR’s network, technical expertise and pilot-scale facilities, funding and workforce development, as well as its contract manufacturing services and market links.

(continued overleaf) ➤➤

MYCOSURE

VEGAN PROTEIN POWDER FOR FOOD COMPANIES

The BIDC has just finished developing a mycoprotein product for MycoSure under the leadership of CSIR principal scientist Dr Ghaneshree Moonsamy.

The starting material for MycoSure's mycoprotein is *Fusarium venenatum*, a fungus known to have a high-protein content.

This organism's fruiting body is similar to other fungal fruiting bodies, including the common mushroom. A fruiting body usually sprouts from a mycelium, which is a network of fungal threads in soil or on a substrate. But when *F. venenatum* is grown in a liquid culture, only mycelium threads grow.

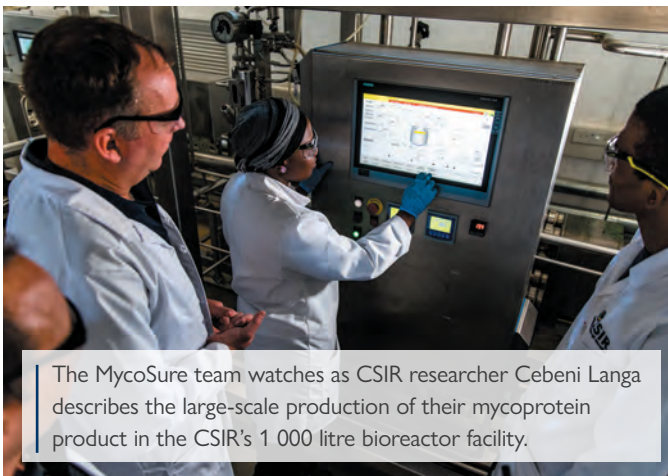
In a bioreactor, with precisely adjusted and controlled conditions in a liquid medium, one can produce this high-protein fungal biomass in the same amount and quality for every batch.

Dehydrated and powdered, it becomes a nutritious supplement called mycoprotein, which can be added to soups, shakes and other foods.

The CSIR has just completed the technology development for MycoSure and has just licensed the technology to them.

While MycoSure's founders push for rapid prototyping in a true entrepreneurial spirit, CSIR scientists and engineers push for thorough safety and quality testing to ensure a safe final product that makes techno-economic sense and is ready for the market.

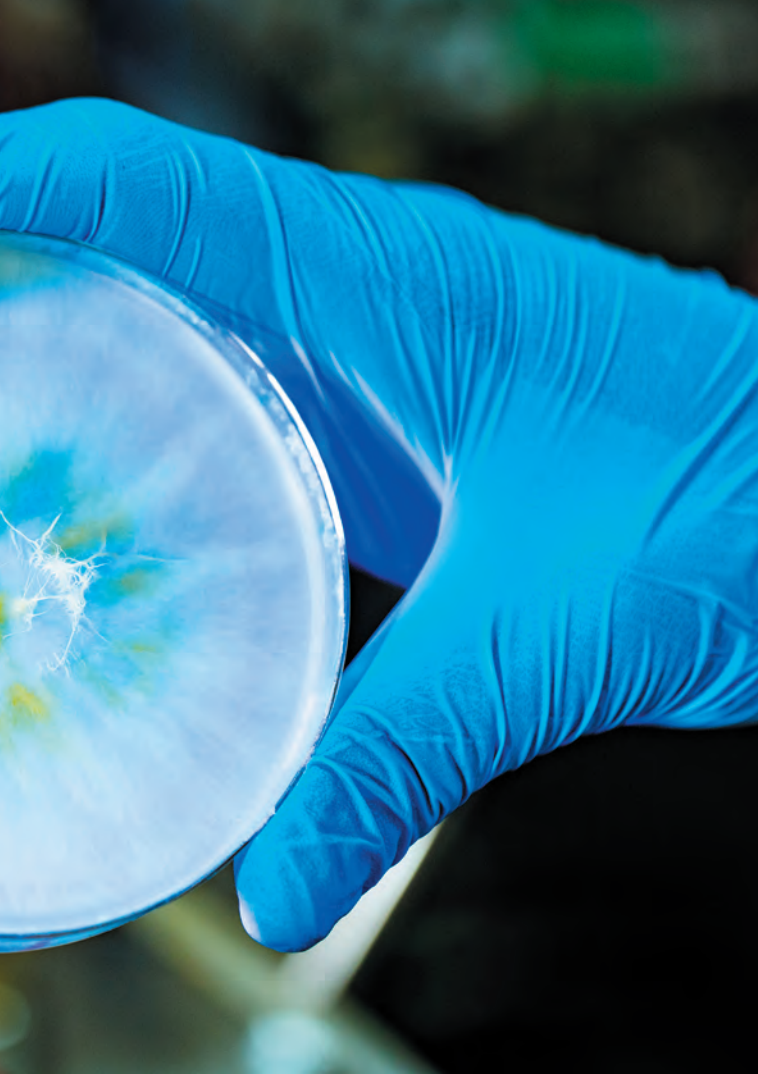
The next step for this pre-revenue company will be to scale up production from 1 000 litres. For now, while the company perfects its product, tests its market and sets up its biomanufacturing facility, further work may continue at the BIDC.



The MycoSure team watches as CSIR researcher Cebeni Langa describes the large-scale production of their mycoprotein product in the CSIR's 1 000 litre bioreactor facility.

A network of fungal threads known as a mycelium grows on a nutritional substrate in a petri dish. Using bioreactors, the CSIR has scaled up the production of the fungal biomass for SMME MycoSure. This mycoprotein product serves a high-protein vegan food supplement.





CSIR principal scientist Dr Ghaneshree Moonsamy shows MycoSure's YES intern, Lindelwa Shongwe, how to inspect the quality of dried mycoprotein. Shongwe will join the SMME to set up its own manufacturing plant once his training at the CSIR is complete.



MycoSure's plant-based mycoprotein powder is shown here as a final product after drying and milling. The powder will be marketed to food manufacturers as a locally produced nutritious food supplement.



(Left) A combination of entrepreneurial spirit from local SMME MycoSure and technical rigour from CSIR scientists fast-tracked the production of a high-quality, nutritious and safe vegan mycoprotein powder. The CSIR has licensed the production technology to MycoSure. The team, from left: Lindelwa Shongwe, Charles Reed (MycoSure), Cebeni Langa, Dr Ghaneshree Moonsamy, Yrielle Roets-Dlamini, Tsepo Ramohomane, Frances O'Brien and Greg Brown (MycoSure).



Probiotics marketed by Velobiotics (Pty) Ltd.

VELOBIOTICS

PROBIOTIC CAPSULES FOR THE PUBLIC

Anything taken through a person's mouth must go through their stomach at a very low pH.

Dr Chomba Chuma, a medical doctor who regularly prescribed probiotics to patients recovering from illness after a course of antibiotics, came to the CSIR in 2016 with concerns around the quality of imported probiotics. He also worried that these probiotics might not survive the strong acidic environment of the

stomach before moving into the intestines, where they normally reside.

The CSIR then tested its own patented polymer technology as an encapsulation for the probiotics so that they could withstand acidic environments under the leadership of CSIR chief researcher Santosh Ramchuran and CSIR principal researcher Phillip Labuschagne.

While CSIR researchers cannot test the medical validity of this kind of claim, they can simulate stomach acid and the alkalinity of the gut to see if the probiotics are able to revive after going through such a harsh environment.

Chuma had then wanted to see if the probiotics could be produced locally because, at the time, all probiotics in South Africa were imported.

The BIDC took his guidance on what he had identified as the priority strains and developed manufacturing processes for those. The doctor's company, Lighthouse Healthcare (Pty) Ltd., licensed the probiotic manufacturing technology for his new Velobiotics brand.

Velobiotics now sells different formulations, including shakes for feminine health and for bulking up after illness, on popular online platforms and in pharmacies.

Since there is no existing manufacturing industry for probiotics in South Africa yet, the BIDC can continue to manufacture probiotics at a competitive rate.



OPTIMUSBIO

BIOACTIVE, BIODEGRADABLE DRAIN CLEANERS FOR HOUSEHOLDS

OptimusBio sells cleaning agents, car care products, skincare creams, hand washes and even water treatment products – all formulated using eco-friendly microorganisms from the CSIR’s library.

With OptimusBio’s drain cleaning granules, for instance, the active ingredients come from indigenous beneficial bacteria which colonise the drainage system, effectively breaking down the food waste that typically clogs household plumbing.

The CSIR has a large library of microorganisms with beneficial applications collected from all over South Africa. In the case of OptimusBio, they were screened for their ability to break down fats and oils and to break down bad smells.

By screening for such useful abilities, the CSIR identified more and more applications for these local *Bacillus* bacteria, and eventually OptimusBio was born as a spin-off company in 2014.

The B IDC assisted with product and process development under the leadership of CSIR principal scientist Dr Ghaneshree Moonsamy and the microorganisms used in their products are still contract manufactured at the CSIR today.



| A range of OptimusBio products.



CSIR researchers sourced useful biomolecules from the soil in the Kogelberg Biosphere Reserve, one of the world's most biodiverse areas.

CAPEBIO

USEFUL ENZYMES AND KITS FOR DIAGNOSTICS AND FORENSICS

CapeBio's big break came during the Covid-19 pandemic when it developed a coronavirus testing kit, or as it became commonly known, a polymerase chain reaction (PCR) test. Their diagnostic kit is the culmination of work that started at the CSIR many years ago when researchers began scouring the Cape Floral Kingdom for unique and useful biomolecules like enzymes. A PCR test relies on an enzyme to multiply DNA – if the DNA of a virus is present in a sample, it will be amplified to a detectable level and yield a positive result.

CapeBio's founder, Daniel Ndima, joined the BIDD as an intern in 2015 and quickly showed an interest in entrepreneurship. Ndima joined the biomanufacturing technology demonstration group under CSIR chief researcher Dr Tsepo Tsekoa.



A researcher demonstrates a step in producing useful enzymes.

Tsekoa's group screened many microorganisms collected from the Cape Floral Kingdom, looking for novel enzymes.

Ndima licensed some of these useful enzymes from the CSIR in 2020 after establishing CapeBio. The company has since developed other useful biomolecules and manufactures diagnostic and forensic kits.

Ndima's success in building his career from intern to CEO demonstrates the two legs of the BIDD: enterprise support and workforce training.

RESYN™ BIOSCIENCES

MAGNETIC MICROPARTICLES FOR RESEARCHERS

ReSyn™ microspheres are minute magnetic beads made up of tiny strands coiled together like a ball of wool. The beads can be engineered to attract biological molecules that research scientists are interested in, such as antibodies, enzymes or DNA. Once the target molecule sticks to the bead, it can be removed from a mixture, such as a blood sample, using a simple magnet.

This bead technology, which has applications in research fields as broad as diagnostics, industrial processes and forensics, was developed at the CSIR. It was licensed to ReSyn™ Biosciences in 2016, making it one of the first BIDC enterprises to license technology from the CSIR.

Several scientists have also spun out of the CSIR with ReSyn over the years. As the company has grown, it has grown its own staff and developed more products.

The BIDC still provides contract manufacturing services to this growing enterprise and benefits from royalties.



WORKFORCE TRAINING

More than 200 interns have been trained as part of the BIDC's support for small and medium businesses.

"We take recent graduates in biochemistry, biotechnology and engineering, and we give them a yearlong exposure to our product development work," says Kotzé-Jacobs.

The CSIR is also part of the Youth Employment Service (YES) Programme. "For some of our YES interns, we ask our enterprises which of them have a need for an intern that can come and work in the business and learn from them," she says, adding that the CSIR and the enterprise will conduct the interview together. In this way, the intern gains valuable work experience while the enterprise benefits from a sponsored employee.

"Both of us benefit because we can place an intern with a partnered enterprise and contribute to job creation for the youth of SA; and for those enterprises, if they've gotten the right person, they will stick with them and it's a relationship that will hopefully result in permanent employment."

ENQUIRIES:

>> **Lara Kotzé-Jacobs**

lkotze@csir.co.za

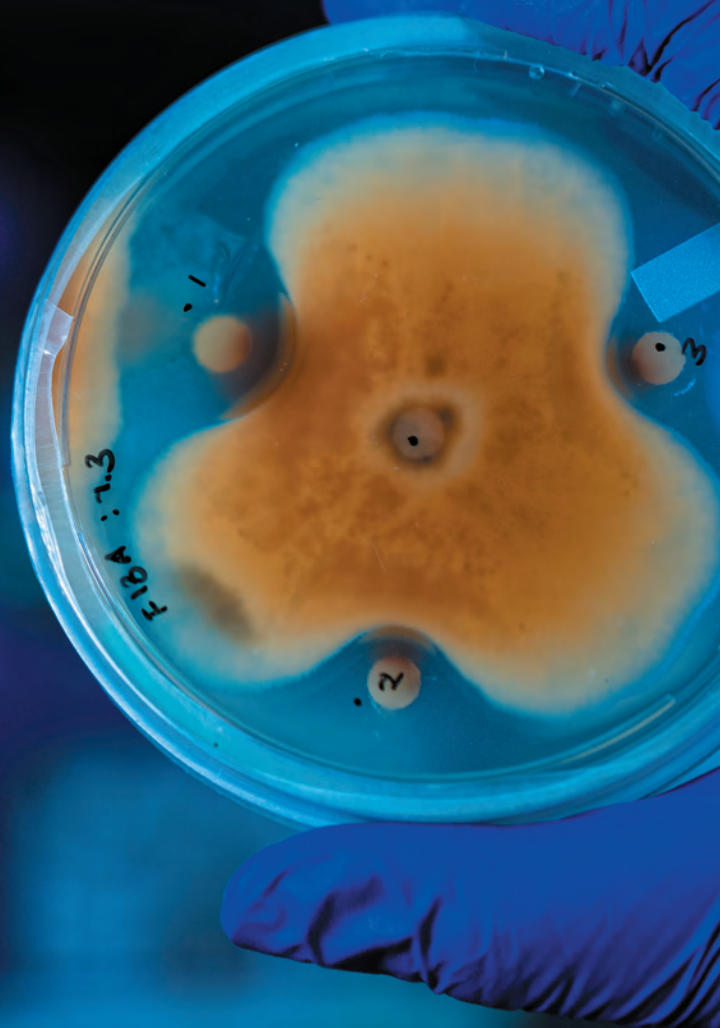


OUT WITH HARSH CHEMICAL SYNTHESIS; IN WITH ECO-FRIENDLY BIOCATALYSIS

From bug sprays and perfumes to cattle feed and flotation oils, no industry is off limits for Dr Lucia Steenkamp's team at the CSIR's Industrial Biocatalysis Hub (IBH). Her team draws on the CSIR's extensive library of local and internationally sourced enzymes and microorganisms to help local businesses extract, convert or create useful compounds in an eco-friendly way.

"We use microorganisms and enzymes rather than harsh chemistry to help local businesses develop useful products."

- Dr Lucia Steenkamp, CSIR





Dr Lucia Steenkamp's team of researchers at the CSIR's Industrial Biocatalysis Hub (IBH) uses microorganisms and enzymes, rather than harsh chemistry, to help local businesses develop useful products. "We have already finalised three products (licensed) and are finalising another 10 prototypes," says Steenkamp.

"I'm not one of those people who can do fundamental research and look at things at the microgram scale every day; I want to see something being put into the market," she says.

"The IBH's biggest mandate is to support SMMEs and entrepreneurs to help them develop green technologies so that they can commercialise them."

Depending on the business's requirements, IBH researchers will choose either a whole microorganism or an enzyme to create products naturally, without using harsh or dangerous chemical methods.

Steenkamp says biotechnology entrepreneurs have brought her materials as diverse as paper waste and citrus peels, hoping to turn them into novel products like bioplastics, animal feeds, fragrances, modified plant oils, insecticides, fungicides and drug precursors.

Since 2021, when the hub was commissioned by the (then) Department of Science and Innovation and the Technology Innovation Agency, Steenkamp's team has already researched, developed and scaled up an impressive number of technologies for small businesses. "We have licensed three technologies in two years and are planning to license four to five in the 2024/25 financial year," she says.

"We provide SMMEs with networking opportunities and funding and research," says Steenkamp, adding that once the CSIR demonstrates the technology, it is licensed to the company and the technology is transferred.

"We help them to scale up and to conduct first runs until they are comfortable to build on their own," she says.

The IBH also takes on interns with BSc Hons degrees, with the aim of placing them in permanent employment with SMME partners. Young researchers are assigned to work on SMME projects, including Master's and postdoc students, so that they gain the skills and experience to grow into principal investigators.

Steenkamp says this skills training and SMME support model boosts the whole bioeconomy of South Africa, and particularly the biomanufacturing industry.

Unfortunately, she says, biocatalysis is still a niche area in the country, and more people need to know about its potential to help businesses innovate.

For this reason, her team will soon embark on a national roadshow. "We plan to present the hub in every province by January 2025, and to invite interested SMMEs and entrepreneurs to bring their ideas and to apply via our formal calls for expression of interest."

(continued overleaf) >>

An MSc student prepares a sample of wastepaper and pulp for processing into animal feed components for local SMME Khepri Biosciences.



KHEPRI BIOSCIENCES

ANIMAL FEED PRODUCTS MADE USING PAPER WASTE

During times of drought, grazing ruminants often need extra nutrition. Unfortunately, many low-income farmers cannot afford additional feed for their cattle and sheep.

Khepri Biosciences is a Krugersdorp-based biotechnology enterprise that turns waste products into sustainable, low-cost animal feed products.

“They came to the CSIR with the idea of using waste pulp and paper to create something for the animal feed industry,” says Steenkamp.

“We have now found enzymes that can break down the paper into valuable products, and we are also trying to beneficiate the lignin that stays behind,” she says.

The next step will be scaling up production, and the technology should be transferred to Khepri to take to the animal feed market by March 2025.



PAROMATICS

BIOPLASTICS MADE FROM SUGAR

Glucose can be turned into a new-generation bioplastic using biocatalysis.

The product from the biocatalysis is a monomer which can be linked together to form a polymer, which is the material commonly known as bioplastic.

“The CSIR found that the conversion is a two-step process. For the second step, we found more than one microorganism that can convert an intermediate to the monomer bioplastic, but one of them in particular is really, really good,” says Steenkamp.

Those enzymes were sourced from the CSIR’s library, as well as soil and manure samples, and will ultimately help local company Paromatics produce next-generation, eco-friendly bioplastics.

Traditional plastics are made using harmful chemical processes and fossil fuels, but Paromatics approached the CSIR with the idea of using sustainably sourced glucose as their starting material.

“They can now actually make this new-generation bioplastic in a way that is totally green, instead of using chemistry,” says Steenkamp.

She says the CSIR should be able to scale up the biocatalysis process for Paromatics by June 2025.

A CSIR researcher prepares for a sterile inoculation of a microorganism that can turn pure sugar into a plastic precursor. The technology will enable local SMME Paromatics to produce eco-friendly bioplastics.



A CSIR laboratory technician uses biological compounds to modify a plant oil, which SMME Recobre Projects will offer the mining sector as a cheaper local alternative for mineral flotation.

RECOBRE PROJECTS

MODIFIED PLANT OIL FOR THE MINING INDUSTRY

The mining industry imports 10 000 tonnes of a particular modified plant oil every year. They use the oil to extract important minerals from their own waste streams in a process known as flotation.

“An engineering consultation company called Recobre Projects asked us to look at producing this modified plant oil using biocatalysis instead of chemistry,” says Steenkamp, adding that the enterprise wants to offer the product as a cheaper local alternative to importing.

“We have had good results so far and we are ready to start scaling up,” she says.

STILHOEK BOERDERY

NATURAL FUNGICIDE FOR FRESH PRODUCE

South Africa’s biggest exporter of passion fruit, Stilhoek Boerdery, approached the CSIR for a more natural way to protect its produce from fungi.

“We found a microorganism that can kill the fungi,” says Steenkamp. However, being quite a novel discovery, the CSIR is still investigating whether the fungicidal activity is due to a compound excreted by the microorganism, or due to an enzyme within the microorganism.

“If this works, it can probably be used in the export of all other fruits and vegetables from South Africa,” she says. Being a natural antifungal, she explains that farmers would be able to spray it while growing and just ahead of exporting, since it would comply with strict European Union rules against harmful pesticides.

Steenkamp’s team hopes to finalise investigations and scale-up production by June 2025.



Globules of a microorganism with anti-fungal properties sinks to the bottom of a flask. The CSIR will determine if the creature excretes a fungicidal compound or if it contains a special enzyme that digests fungus, so that agricultural SMME Stilhoek Boerdery can use the technology to naturally prevent fungal growth during the growth season as well as preserve their granadillas during export.

A CSIR researcher holds a vial of white Aloesin powder, which was produced via a biocatalytic step and then purified from an aloe sap mixture, for SMME Biosolve.



BIOSOLVE

ALOE-BASED COSMETIC PRODUCTS

The CSIR is currently redeveloping a method to produce a natural skin lightening compound called Aloesin.

“Recently, there has been a huge demand for this product in the cosmetic industry,” says Steenkamp. Scientific studies suggest that Aloesin may inhibit pigmentation and could speed up wound healing.

The resin of the South African *Aloe Ferrox* plant can be converted to Aloesin using either an acid hydrolysis or an alkaline hydrolysis, or even a hydrolytic enzyme.

Steenkamp says a company called Biosolve battled to produce Aloesin using the licensed technology. “We’ve now taken on the project to see how we can change the hydrolysis and the downstream process to get the Aloesin out for use in cosmetics.”

A measure of racemic phenibut powder, an ingredient used in the production of sleeping pills, antipsychotics and other pharmaceuticals. The CSIR developed a green chemistry method to produce the compound without the explosive risks associated with traditional chemical manufacturing. The method has been licensed to SMME Linuset.


LINUSET

DRUG PRECURSOR FOR GLOBAL PHARMACEUTICAL COMPANIES

The CSIR assisted entrepreneurs at Linuset to produce a common drug precursor, racemic phenibut, using a safer, eco-friendly method.

Racemic phenibut is often used as a central nervous system depressant, enhancing the effects of sleeping pills, antipsychotic and antiparkinsonian drugs. It can also be used as an intermediate in the production of other pharmaceuticals.

“If this compound is produced using classical chemistry, there is a huge chance of an explosion – it is a very dangerous synthesis to do at scale,” says Steenkamp. “The CSIR has



The root of an iris flower is traditionally converted into a sought-after essential oil called orris butter over several years. The CSIR discovered that a cheap enzyme can bio-catalyse the process in just 48 hours. SMME Puris will use this low-cost, high-yield technology to supply international fragrance markets.

PURIS

RARE NATURAL PERFUME COMPOUNDS

Orris butter is an expensive and rare essential oil with an earthy aroma. "It sells for up to 70 000 US dollars, and is used in very expensive perfumes," says Steenkamp.

"Normally, one would produce orris butter by taking the roots of these beautiful purple iris flowers – the orris roots – and incubating them for three to five years under very specific conditions," she says.

"But the CSIR found a very cheap enzyme that can do this process in 48 hours."

An SMME called Puris will now use this natural low-cost, high-yield technology to supply orris butter to international fragrance formulators, says Steenkamp.


The CSIR is also working with Puris to make other expensive compounds usually extracted from maple syrup and rose, using the natural biocatalytic action of microorganisms or enzymes.

The first is maple furanone, the active ingredient in maple syrup tapped from maple trees. "There's only so much they can tap per year," says Steenkamp, "and it can be synthesised chemically, but that is not a natural method." Research and development for this compound is complete, with licensing underway.

Next is beta-ionone, a floral scent usually extracted from rose oils. A novel method was developed using biocatalysis to produce the compound, and Steenkamp says her team is currently scaling up production.

"The last one is beta-damascenone – the most expensive flavour compound, selling at R1.5 million per kilo," says Steenkamp. Only tiny amounts of the compound are usually extracted from rose.

"We have not yet cracked it, but so far we have managed to make alpha-damascenone," she says, confident the team will soon make a breakthrough.



enzymes called nitroreductases that can catalyse the same reaction, but without the risk of explosion."

The CSIR developed a final green technology for the synthesis of racemic phenibut, and licensed it to Linuset.

"Linuset will commercially produce it as a drug precursor to meet growing demand in the United States, which has been triggered by a decline in the quality of material provided by other countries," says Steenkamp.



Members of the CSIR's Industrial Biocatalysis Hub team and local small business APBio. The CSIR developed an enzymatic process for the SMME to manufacture citrus-based insect repellent. Front from left: Moloko Mathiba-Mdikane (CSIR) and Deidre Davids (APBio). Back from left: Dr Lucia Steenkamp (CSIR) and, from APBio, Stephanus Marais, Lungile Mguni and Tawanda Chakanya.



APPLIED PROTEIN BIOTECHNOLOGIES

CITRUS-BASED INSECTICIDE/INSECT REPELLENT

Add some enzymes to a blend of natural citrus oils and voila: an eco-friendly insect repellent.

“Applied Protein Biotechnologies (APBio) came to us with the initial concept, and we scaled it up and improved it,” says Steenkamp.

“We made 17 litres of market sample for them, transferred the technology and now they are doing really well.”

On their website, the team says this process mimics nature – all they are doing with the enzyme cocktail is speeding up the process that would occur naturally when a citrus fruit matures.

They say their NOOT-A-BUG® insect repellent can be used against flies, mosquitoes, ticks and other insects, and even works against insects in agricultural settings.



A CSIR technician injects a citrus extract into a bioreactor to produce the natural NOOT-A-BUG® insect repellent for SMME APBio.

ENQUIRIES:

>> **Dr Lucia Steenkamp**

lsteenkamp@csir.co.za

ONE MAN'S TRASH IS ANOTHER ONE'S TREASURE, AS LONG AS IT IS BIOREFINED

Entrepreneurs have brought chicken feathers, black soldier fly larvae, sawdust, cow dung and even used X-ray film to the CSIR Biorefinery Industry Development Facility (BIDF). While not every one of these waste products could be converted into something useful that can be sold again, CSIR chemists and engineers have helped over 20 budding biorefinery businesses find their place in South Africa's bioeconomy since 2018.

Dr Viren Chunilall, CSIR principal researcher and BIDF research group leader, says that as long as an enterprise has access to a sustainable feedstock that the CSIR's equipment can handle, his team can look into refining that waste product biologically or chemically.

"Biomass in the form of plant waste works best as a feedstock," he says. "Forestry waste like sawdust and alien invasive plant species, as well as food waste from your farmer's markets and hotels, are easy for us to process."

One process they have developed is the conversion of hemp waste into paper products.

He explains that once medicinal cannabis oils have been extracted from hemp, a fibrous mass containing lignin and cellulose remains. This can be processed into pulp, which can then be used to manufacture common items like tissue paper, cardboard and fine paper.

In 2014, when the CSIR partnered with the (then) Department of Science and Innovation to establish the BIDF, Chunilall and his fellow researchers began biorefining agricultural and woody biomass waste.

Once fully established in 2018 and with additional support from the Department of Science, Technology and Innovation (DSTI), the CSIR began partnering with SMMEs to transfer some of its biorefining technologies. It also took on a technology development and advisory role to support South Africa's growing biomanufacturing industry.

Chunilall cautions, however, that South Africa's market for biorefined products is still not well developed.

Keratin, for example, a key ingredient for the cosmetics industry, is fully imported into South Africa. "We are talking about 30 000 to 40 000 tonnes of this material each year," says Chunilall.

The BIDF recently developed a way to extract keratin from waste chicken feathers, and the technology has been licensed to a local company, Polyftero. Chunilall says the company plans to build a manufacturing plant in South Africa, which will hopefully spur the market to purchase this ingredient locally.

More than 20 other local entities have benefitted from the BIDF's business support, says Chunilall. Four of these stand out as successes, demonstrating the full spectrum of business support provided by the CSIR: Ziziba, Oratech, Finishes of Nature Global and Corruveal.

As for the black soldier fly larvae and X-ray films, Chunilall's team advised the enterprises on how they might benefit from the waste. The larvae could be converted into fertiliser, protein and oil, while silver could be extracted from the X-ray films, leaving the plastic, which could itself be used in recycled plastic products.

Sometimes, though, the business case does not make sense, even if the science does.

Chunilall recalls one instance where a company approached the BIDF to test the biodegradability of an imported plastic to be used in sanitary pads and nappies. "The advice we gave them was not to bring this plastic into the country because it makes harmful microplastics, so it will create more of an environmental concern than anything useful," he says.

"We can't tell the SMME only what it wants to hear; we tell them exactly what the science tells us."

He says it is this commitment to quality and safety testing, as well as solid chemical and engineering science, that companies rely on when they partner with the CSIR.



CSIR chemical engineering technologist Londani Mbambo with fibres recovered from used potato bag pulping. As part of this work, the CSIR has designed a fibre recovery pilot plant for paper-based waste streams.

(continued overleaf) >>



CSIR senior researcher Yrielle Roets-Dlamini with fish feed pellets formulated using single-cell protein technology. (Below) Products generated from all the product stages.

ZIZIBA

FISH FEED PELLETS MADE FROM INDUSTRIAL FOOD WASTE

Micro-enterprise Ziziba has access to organic waste streams from the sugar, corn and forestry industries.

“Waste products like molasses and corn steep liquor, for instance, have a very high sugar content and we can convert the glucose component into protein,” says Chunilall.

The CSIR developed a biorefinery process for Ziziba in which the waste glucose is used as feedstock to grow fungal biomass. This biomass is rich in protein, so it can be dried and formed into pellets.

“Internal and external tests confirmed that it is nutritionally comparable to the protein-rich ingredients used in commercial fish diets,” says Chunilall.

He says the company already has potential international buyers for the pellets, including an Egyptian partner needing 10 000 tonnes per year.

“They are also in discussions with the trade port at Coega in the Eastern Cape to set up a commercial manufacturing plant,” he says.

Talks are now underway for the CSIR to contract manufacture the fish feed product until the plant is built and to invest in the plant through its commercialisation enterprise, CSIR C³.



FINISHES OF NATURE GLOBAL

BIODIGESTERS FOR COMMUNITY KITCHEN-GARDENS

The CSIR helped an SMME called Finishes of Nature Global (FONG) to set up a biogas plant at a school in the Eastern Cape.

“The school had been using liquid petroleum gas in the kitchen to cook meals for the kids,” says Chunilall. “Now, they are generating their own gas, and the biogas process also generates biofertiliser for the school’s vegetable garden.”

The CSIR used its bench-top biodigester to optimise the yield of methane gas from the mix of biomass input available at the school. It then assisted FONG to procure, install and customise the full-size biogas plant for the school’s needs.

Chunilall says that 11 women from the community tend the school garden. They give 30% of their produce back to the school kitchen for the children’s meals and sell 70% to earn an income.

CORRUSEAL

BIO-GLUE FOR CARDBOARD BOXES, MADE FROM ENZYMES

Packaging enterprise Corruseal’s corrugated cardboard packaging is usually made up of three layers, with starch bonding the centre layer to the outer layers.

“They wanted to replace the starch-based glue, and the CSIR advised them to use an enzyme-based bonding technology,” says Chunilall, adding that the interaction tells a good story of how the BIDE, together with colleagues who are experts in biotechnology, supports SMMEs in a technology advisory capacity.

The expert advice comes in the form of an official report. Despite not resulting in a technology demonstration or a licence, it is considered a success when the enterprise takes on the advice and achieves growth as a result.

“Corruseal started buying the enzyme and went on to test and implement the enzyme-based bonding at commercial scale for paper and packaging,” says Chunilall.



ORATECH

MINE DUCT COATING, MADE FROM CHARRED TIMBER WASTE

In South Africa, an expensive powder called carbon black is imported from abroad to coat the air ducts through which oxygen is pumped to underground miners.

“Carbon black is an anti-static coating that prevents friction, so it prevents potential fires in the mine itself,” says Chunilall. He adds that a product to substitute carbon black could be made locally in South Africa using a component of biochar.

The BIDE has a pyrolyser machine that makes biochar. It creates a charcoal-like powder by heating woody biomass to around 500 °C.

Chunilall says the CSIR conducted a feasibility study for small business Oratech to produce biochar from alien invasive trees, acacia tree plantation waste and timber waste from underground mines.

He says they have developed a biochar-based carbon black alternative, which has attracted the interest of major technical textiles and personal protective equipment firm, Beier.

“They are testing some of the material that we have produced in their product line, so once Oratech starts manufacturing the biochar, Beier will be an off-take partner for them,” says Chunilall.

ENQUIRIES:

>> **Dr Viren Chunilall**
vchunilall@csir.co.za

RANGE OF CANNABIS PRODUCTS DEVELOPED AND TESTED FOR SMALL BUSINESSES

The CSIR has supported 23 SMMEs with the development of high-quality, regulatory-compliant, safe, efficacious and affordable cannabis products for local and international markets.



Entrepreneurs participating in the cannabis incubation programme, from left, Baile Sexwale, Prestige Mbito, Cecil Matlou, Kabelo Lehloeny, Bernard Dakile and Sfeziwe Chili (on behalf of Mzibeni Cele).



CBD-infused products – developed, tested and produced at commercial scale for trade in formal markets.

SCAN TO WATCH THE VIDEO STORY



South Africa's cabinet decided in July 2019 that the country needs a national strategy to commercialise cannabis to increase economic growth, create jobs and alleviate poverty. The resulting National Cannabis Master Plan highlights that the cannabis sector has huge potential for the development of SMMEs, attracting domestic and foreign investment and adding value in the processing and manufacturing of products for local and export markets. It highlights the potential for economic diversification, thus increasing economic growth, creating jobs and alleviating poverty.

The CSIR's cannabis platform is supported by the Department of Science, Technology and Innovation (DSTI), the Gauteng Department of Agriculture, Rural Development and Environment and the Department of Small Business Development.

The SMMEs met all the requirements for CSIR product-development support and progressed to the stage of having commercially ready cannabis-infused products. Market samples handed over to the enterprises were produced on a commercial scale in facilities approved for good manufacturing practices, ready to be traded in formal markets.

Outlining the process, Phatheka Ndzotoyi, acting research group leader of agroprocessing at the CSIR, says, "The CSIR hosted sessions with the enterprises on regulations in the cannabis sector, compliance, quality and safety testing requirements, prototype development and branding/artwork regulations for nutraceuticals, cosmeceuticals and herbal remedies."

"These sessions included a tour of the CSIR's agroprocessing facilities, where the enterprises observed the cannabis extraction process using the supercritical carbon dioxide equipment at the pilot plant and prototype development in our laboratories," she says.

These engagements culminated in the CSIR assisting SMMEs to develop over 40 cannabidiol (CBD)-infused and cannabis-based prototypes, including nutraceuticals, cosmeceuticals and herbal remedies. CBD-containing products such as gummies, oil drops, sodas, water, hair oils, pain relief creams, shower gel, face wash and face oil have been produced on a commercial scale and transferred to the relevant SMMEs across South Africa, representing eight of the country's nine provinces, to support their commercialisation endeavours.

"The next phase of this project is to engage the Department of Trade, Industry and Competition to provide commercialisation support to these enterprises. This includes scaling up the production of all the products developed by the CSIR and introducing the products via platforms such as expos and trade shows," says Ndzotoyi.



Eleven rural communities across South Africa are set to benefit from phase two of this initiative in the 2024/25 fiscal year. The CSIR has received funding support from the DSTI to integrate rural communities into formal cannabis value chains.

CANNABIS: HEMP AND DAGGA

The scope of South Africa's National Cannabis Master Plan includes both hemp and dagga, which are two closely related plant varieties that belong to the cannabis genus.

The cannabis plant contains at least 70 unique compounds known as phytocannabinoids, including tetrahydrocannabinol (THC) and cannabidiol (CBD). THC is a cannabinoid that produces a psychoactive effect and also has medicinal properties, while CBD is predominantly associated with medicinal properties. Hemp plants contain lower levels of THC.

While medicinal cannabis is grown under protection for optimum results, hemp for industrial use is generally suitable for open-field production.

ENQUIRIES:

>> **Phathekha Ndzotoyi**
pndzotoyi@csir.co.za



SMMEs in the agricultural sector have been trained on converting food waste into high-quality biocompost. This is the first harvest of baby marrows produced using the compost at Kenokatha Farms in Midrand, Gauteng.

SCAN TO WATCH THE VIDEO STORY



BIOCOMPOST FROM FOODWASTE REPLACES CHEMICAL FERTILISERS

The CSIR has trained eight agri-businesses on how to use a biocompost technique to process food waste into highly nutritious biocompost that can replace expensive chemical fertilisers used in farming.

South African businesses and households have to reduce food losses and waste, estimated at more than 10 million tonnes per year – more than a third of the local food production. Eight emerging farmers who are contributing to combating food waste by using the food waste from households, commercial kitchens and vegetable markets for biocompost have completed specialised training on this subject at the CSIR. These farmers are Khepri Innovations, Mathibe, Kenokhata Farms, Mabinane Poultry Farmers and Zeakhu Group from Gauteng; Smartroots from the Eastern Cape; NDN Agri from the North West and Luke Trading from Mpumalanga.

Ndumiso Ndlovu, CSIR senior technologist and expert in agroprocessing, says, “As part of a nationwide pilot programme, farmers undertook the Bokashi composting process of converting food waste into biocompost. This process includes using food scraps, combined with effective microorganisms, to break down organic waste through fermentation, which involves the anaerobic decomposition of these organic materials.”

Collectively, 13.52 tonnes of food waste have been processed into biocompost over six months, which is being used as an alternative to chemical fertilisers for farmers’ crops.

Farmers were also provided with Bokashi Bran microorganisms, various gardening tools, an assortment of seeds for cultivation and the basic equipment for food waste fermentation and biocompost processing.

Ndlovu says, “The process has proven to be a sustainable and green solution for small-scale farmers and was demonstrated in a joint project of the CSIR and Black Umbrellas through funding from Nedbank.”

One of the first programme beneficiaries to use its self-produced biocompost was Kenokhata Farms in Midrand. The farm converted 2.58 tonnes of food waste into 1.42 tonnes of biocompost and produced a good harvest of baby marrow, having integrated the skills, tools, seeds and their biocompost.

CSIR senior technologist Ndumiso Ndlovu with Quinty Rabophala of Kenokatha Farms in Midrand, Gauteng.



“We are excited to witness farmers harvesting vegetables and fertilising their soil using their compost. The process requires precision during every step, including an urgency in the treatment of food waste sources. We recommend treating food waste with effective microorganisms within four hours of disposal. Once the food waste has been treated with Bokashi Bran microorganisms, the waste ferments in a closed system (out of direct sunlight) under anaerobic conditions,” Ndlovu adds.

The next stage of the programme is to include more small-scale farmers. The intent is to convert at least 50 tonnes of food waste to biocompost, create employment and improve income generation for farmers.

ENQUIRIES:

>> **Ndumiso Ndlovu**
nndlovu3@csir.co.za

BOREHOLES AND BASINS TO BANISH BAKERY BACTERIA

The CSIR is supporting two rural bakeries in Limpopo to obtain food safety compliance and certification from local municipal authorities and the Department of Health.

All South Africans have the right to safe, high-quality products, a right protected by South Africa's Consumer Protection Act. When it relates to food products, the South African government has introduced numerous regulations to help ensure food safety, from regulations governing general hygiene requirements for food premises to water quality standards and food safety management regulations. For SMMEs, managing these requirements can be challenging.

Two SMMEs in the Sekhukhune District Municipality faced the challenges of complying with food safety regulations. With its rich expertise and knowledge about food safety and its associated regulations, the CSIR assisted the SMMEs with the support of the Nozala Trust, which funded the initiative. Tswelopele Bakery and Mafato A Bokgwale Bakery produce bread, buns and magwinya (African fat cakes), which are sold in their respective local communities.

Dr Nomusa Dlamini, CSIR research group leader for food safety, says the CSIR assisted both bakeries with the installation of handwashing basins and sinks inside the bakeries to improve hygiene practices. Additionally, the courtyards have been paved to reduce dust that could contaminate and compromise the safety of food products.

"Food safety is important to ensure that consumers are not exposed to food-related hazards such as bacteria that may cause illness and chemical contaminants that may be toxic. It is also important for proper handling and storage of food," Dlamini says.

At the Tswelopele Bakery, a borehole was sunk to improve potable and clean water supply for improved hygiene standards. Mafato A Bokgwale Bakery receives its water directly from the local municipality, which was tested and found to be compliant with the South African National Standards for potable water and considered safe for human consumption.



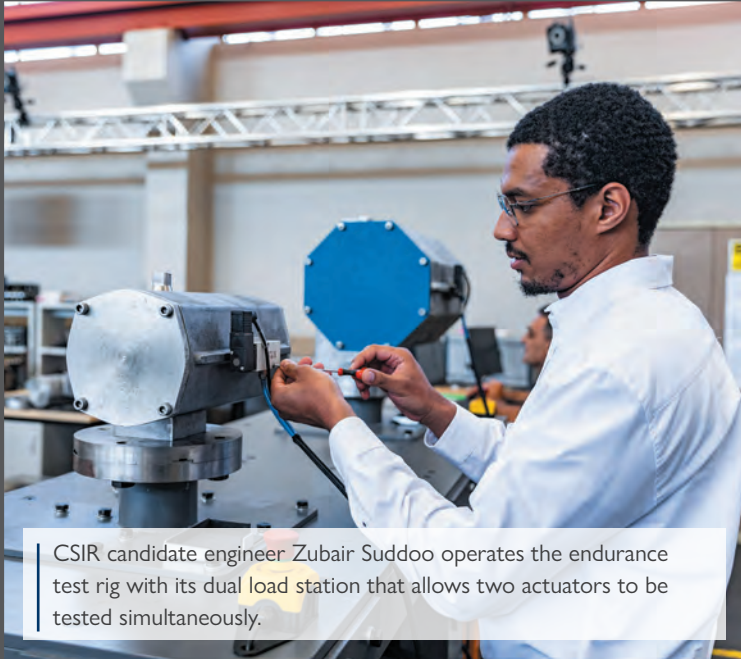
The CSIR is assisting rural bakeries with food safety compliance.

In addition to the rigorous assessment of food safety requirements, the CSIR facilitated food product development training for Tswelopele Bakery personnel covering baked products such as pizzas, soft rolls, buns and vienna rolls, which are popular in the local communities based on a feasibility study on how the bakeries could expand their market offerings.

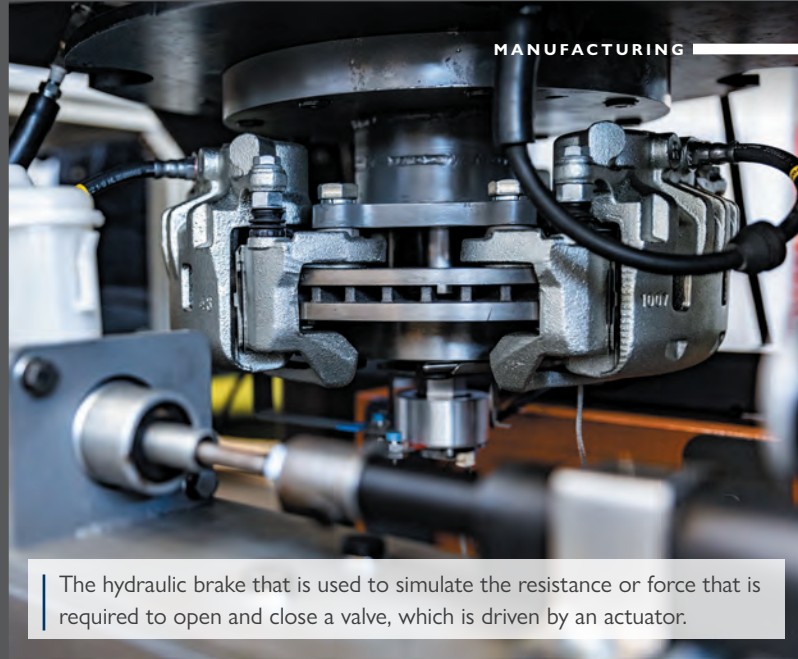
"Future plans include the introduction of these products as part of both bakeries' product offering to supply local petrol stations, supermarkets and other facilities such as clinics and hospitals," Dlamini says.

ENQUIRIES:

>> **Dr Nomusa Dlamini**
 nrdlamini@csir.co.za



CSIR candidate engineer Zubair Suddoo operates the endurance test rig with its dual load station that allows two actuators to be tested simultaneously.



The hydraulic brake that is used to simulate the resistance or force that is required to open and close a valve, which is driven by an actuator.

TEST BENCH FOR PNEUMATIC ACTUATORS

CSIR experts in robotics and engineering have developed a novel test bench that can simultaneously test two pneumatic actuators for the KwaZulu-Natal-based SMME, Aumanat.

Aumanat specialises in complete valve automation solutions for the petrochemical and wastewater treatment industries. The SMME manufactures pneumatic actuators and is an agent for a leading electric actuator brand, AUMA. Its product range includes valve gearboxes for various industrial applications. The Aerospace Industry Support Initiative (AISI), a South African Government initiative to improve the competitiveness of the local aeronautics, space, defence and sector-wide advanced manufacturing industries, commissioned the CSIR to assist Aumanat.

Pneumatic actuators utilise compressed air to produce mechanical motion and force. These devices are used in industrial applications requiring controlled and precise movement and operation, such as valve control and isolation used in the water and waste sector, as well as power generation, paper, sugar, steel mills and most industrial plants.

The new test bench continuously monitors parameters specified in EN 15714-3:2009, the international standard used for endurance testing of pneumatic actuators. "An example is the torque that needs to be adjusted to the correct level and logged every 15 degrees when opening and closing the valve. Endurance testing requires millions of cycles, hence the capability to test two actuators of different sizes simultaneously, saves a lot of testing time," says Peter Meyer, director of Aumanat.

The CSIR developed a user requirement specification document according to the certification standards to ensure market acceptance. This European standard helps companies ensure safety and quality in manufacturing processes.

AISI has supported more than 40 local companies in 2023/24 as part of its commitment to assist local companies to develop and localise technologies, contributing to economic growth and enhancing the country's manufacturing capabilities.

"We are extremely grateful to AISI and the CSIR for their involvement in this project, which will result in numerous benefits to Aumanat, the industry and ultimately the country," says Meyer. "The design, manufacturing and assembly of pneumatic actuators has upskilled my staff and has resulted in the employment of an additional technician and quality controller."

ENQUIRIES:

>> **Livison Mashoko**
lmashoko@csir.co.za



Cannisters that contain the metal powder that is deposited into the 3D metal printer to manufacture items.

(Left) Marius Vermeulen of local company Adiviv interacts with the user interface that allows an operator to programme the machine and to see the status of the part that is being printed, such as a jet engine fan (bottom left).



METAL 3D PRINTER MANUFACTURER NUDGES CLOSER TO CERTIFICATION

Conventional machining and manufacturing technologies are complemented by rapidly developing laser-based 3D printing technologies. The Aerospace Industry Support Initiative (AISI) is assisting Adiviv Solutions to upgrade, test and validate its locally developed and manufactured laser-based 3D metal printer.

Highly regulated industries, such as the aerospace, defence and medical sectors, require guaranteed quality for the parts they use and full traceability of the production process for each printed component. This is no different for 3D metal manufacturer, Aditiv Solutions. With support from the CSIR-hosted programme, AISI, the enterprise launched a project to enhance the relevance of its newly developed flagship machine, HYRAX.

Aditiv Solutions needed to validate the HYRAX machine, ensuring that it meets the needs of regulated industries by providing a 3D printer that ensures traceability throughout the manufacturing process and stores data for certification purposes. The project also highlights the importance of localisation in supporting the HYRAX machine's deployment in different regions, alongside its focus on traceability and data storage.

THE RUN-UP TO THE HYRAX METAL 3D PRINTER

Aditiv Solution's efforts to increase local content began in 2019 when the company developed an affordable metal 3D printer that is easier to operate and requires less supporting equipment than other machines on the market.

"Our machines use a combination of the highest quality German optical systems, and good old South African innovation to ensure quality, reliability and affordability," says Marius Vermeulen, CEO of Aditiv Solutions.

"Our machines are proudly South African, and we hope to make a positive impact on the local machine-building industry."

Aditiv Solutions has taken a holistic approach to developing its technologies, with all hardware and software development being done in-house by a team of engineers and technicians. Apart from the German optical systems in their machines, almost all manufacturing is done locally by specialist manufacturing partners. Machine assembly, testing, installation, commissioning and training are all done in-house.

WORKING TOWARDS QUALITY VALIDATION AND TRACEABILITY

In collaboration with experts at the CSIR, Aditiv Solutions has deployed a fully automated reporting system on their machines to comply with complex certification requirements. The company is also deploying a newer version of the control system for its machines and plans to implement a high-tech filtration system by the end of the year, all of which will be tested and validated in a manufacturing environment.

"Local companies have proven that they have the skills and capabilities to develop advanced technologies. The evolving

technology applied to the HYRAX machine is a case in point. The advancement of technology in the additive manufacturing domain is contributing to locally manufactured parts that are stronger, lighter and more cost-effective," says Erik Wegman, CSIR senior researcher.

"CONTRARY TO SOME MEDIA HYPE, WE DON'T BELIEVE THAT EVERYTHING WILL BE 3D PRINTED IN FUTURE. 3D PRINTING DOES, HOWEVER, HAVE SPECIFIC ADVANTAGES AND WILL BECOME A POWERFUL TOOL FOR MANY INDUSTRIES. WITH THE HELP OF AISI, WE WANT TO ENABLE OUR CLIENTS TO BECOME PART OF THIS REVOLUTION."

– Marius Vermeulen, CEO, Aditiv Solutions.

During a 3D printing process, raw materials such as plastics, resins or metals are deposited, joined and solidified in layers. A component is then built up layer by layer based on the computer-aided design model. Some 3D printers use lasers to heat up and melt metal powder material into solids, others build up solid components by adding layer upon layer of plastics and fusing them using heat.

AISI is a South African government initiative with the specific aim of improving the competitiveness of the local aeronautics, space, defence and sector-wide advanced manufacturing industries. It emphasises the industrialisation of technology and technology-based supplier development. The Department of Trade, Industry and Competition utilises the CSIR and its position in the National System of Innovation as an independent, strategic, directed research and development entity to give industry access to national expertise and infrastructure to improve its capabilities and offerings.

ENQUIRIES:

>> **Livison Mashoko**
lmashoko@csir.co.za

LOCAL PUMPS AND VALVES FOR KOEBERG UPGRADE

Three local manufacturers will supply valves and pumps to the Koeberg Nuclear Power Station – a first since the commissioning of the power plant in 1984. This is thanks to a supplier development initiative driven by the CSIR, Eskom and Électricité de France.

The Technology Localisation Implementation Unit (TLIU), which is hosted at the CSIR, achieved a landmark success with the completion of the Nuclear Components Supplier Development Programme in collaboration with Eskom's Koeberg Nuclear Power Plant and Électricité de France (EDF).

“TLIU sponsored and project-managed the long-term collaboration programme to finality, where the three local companies completed the stringent manufacturing and testing process required at the nuclear power plant,” explains Ashley Bhugwandin, an industrial engineer at the CSIR and manager of the TLIU.

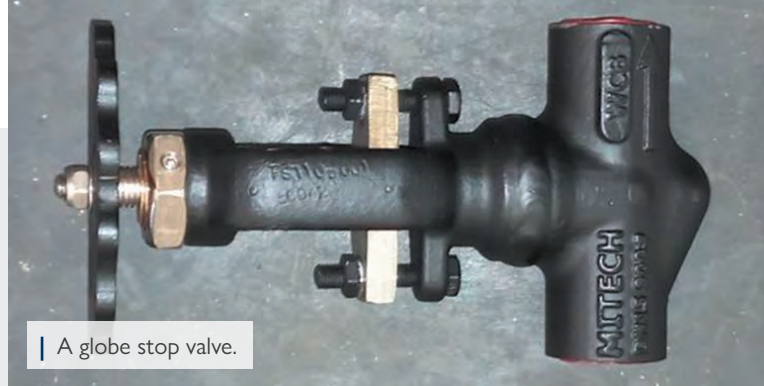
“Garry Wilkins from Eskom was the chief catalyst that organised the initial discussions within Eskom to push the designation agenda so that this project could be realised for the country,” says Bhugwandin.

Two valve manufacturers, Mitech Control Valves (Pty) Ltd. (control valve) and AZ-Armaturen (Pty) Ltd. (plug valve), designed, manufactured and tested their valves, which were delivered and commissioned at the plant.

Another local manufacturer, KSB Valves and Pumps, designed and manufactured a pump, which was also installed and commissioned at the plant.

“Once this project is fully commissioned, these three local suppliers will be integrated within the global supply chain of EDF, which will ensure that these companies realise global opportunities to supply these products,” says Bhugwandin.

The local content requirements are part of the regulations issued by the Department of Trade, Industry and Competition. It promotes local manufacturing and aims to boost the country's industrial base while promoting export opportunities for local manufacturers.



The Koeberg Power Plant operates two 900 MW nuclear reactors, which provide the base load for most of the Western Cape's power needs. The plant was commissioned in 1984.

Every 18 months, each reactor plant is scheduled for statutory maintenance and nearly all of the commodities used in the plant are sourced from Europe. Eskom spends more than R100 million on maintenance projects, and until this intervention, most of that money was spent procuring components from overseas markets.

Eskom has since applied to the National Nuclear Regulator and received a licence to extend the life of the plant by 20 more years.

“The Nuclear Components Supplier Development Programme took advantage of this opportunity, while the planning of the power upgrades was in the early stages around 2012,” says Bhugwandin.

“Several commodities were identified and researched for local manufacturing, and hence, the project was started to support local pumps and valve manufacturers to meet the nuclear quality safety principles.”

Vusi Mahlangu, TLIU project manager at the CSIR, explains that the unit partnered with EDF as a technology transfer partner on the project to draw on its expertise in the nuclear industry. EDF was involved in the construction of the Koeberg Power Plant in the 1980s and currently operates more than 58 nuclear reactors worldwide.

“This initiative enabled the three South African companies to meet stringent manufacturing and testing requirements, leading to the installation of locally manufactured components at Koeberg Nuclear Power Plant. No slight achievement considering the challenges experienced mid-implementation during Covid-19,” Mahlangu adds.

The TLIU is a Department of Science, Technology and Innovation initiative hosted at the CSIR.

ENQUIRIES:

>> **Vusi Mahlangu**

amahlangu3@csir.co.za



CERTIFIED FOR CARE CSIR EMPOWERS MEDICAL INNOVATORS TO MEET GLOBAL STANDARDS

Proudly South African medical products like a circumcision healing brace, an anti-bacterial hospital curtain, and a sheepskin blanket that prevents bedsores, are ready for the market. The CSIR assisted the inventors of these products with obtaining the stacks of paperwork to prove they are manufactured to the highest standard.

The Medical Device and Diagnostic Innovation Cluster (MeDDIC) initiative was established to help SMMEs in the medical technology sector jump through regulatory hoops and to promote localisation of medical devices.

The MeDDIC programme is hosted by the South African Medical Research Council and supported by the Technology Innovation Agency and the Department of Science, Technology and Innovation, with the CSIR serving as a technical partner for the regulatory and technical support component of the MeDDIC programme.

Tiyani Mathebula, quality manager for medical devices at the CSIR's area for industrial sensors, says the programme assists the medical industry by supporting new companies and SMMEs. They work with various government departments for product development and testing, technical documentation, market access and compliance with standards and regulations.

She says the companies involved in the programme work on developing a manufacturing data pack that clearly shows their manufacturing process in line with the necessary complex ISO13485 certification.

"If these companies that are being supported through the MeDDIC programme can demonstrate regulatory compliance for their devices, they will be able to access the market and even export," says Mathebula.

She adds that this will address a key issue in South Africa, which is that the country imports more products than it exports.

"The MeDDIC programme supports local manufacturing and local innovation of products," she says.

The CSIR's role in the MeDDIC programme stems from the Covid-19 pandemic, when the CSIR worked with a number of local medical device producers to deliver ventilators to infected patients struggling to breathe.

The interactions revealed a need for assistance with modern product development approaches, access to regulatory and clinical test networks and guidance to navigate stringent certification and product registration successfully. It also revealed a dependency of the sector on imported products.

MeDDIC focuses on three areas of intervention.

Firstly, on the regulatory front, inventors of medical devices receive assistance with medical device ISO Standard Quality management, medical device classification, standards and identification support, the South African Health Products Regulatory Authority approval process and access to a network of agencies in the clinical testing domain.

(continued overleaf) >>

Secondly, product development support includes configuration management under ISO for electronics, designs or software, development of the manufacturing data pack, contract manufacturing and access to product development service providers.

Lastly, assistance is provided with product manufacturing and distribution, typically facilitated through a network of collaborators.

STOELBAG FOUNDATION

A CIRCUMCISION HEALING BRACE

Stoelbag Foundation is a Soweto-based SMME that manufactures medical devices to assist men, boys and infants with the healing process following male medical circumcision. The Department of Health is currently encouraging medical circumcision as a mitigation attempt to limit HIV transmission.

Using off-the-shelf products and training from innovation incubators, these social entrepreneurs converted their backroom into a factory to make a simple brace that aids healing.

The SMME turned to the CSIR for assistance with ensuring its product meets South Africa’s medical device standards.

CSIR researchers helped the SMME with the documentation needed to comply with health standards and regulations as set out by the South African Health Products Regulatory Authority (SAHPRA) and provide the required information to respond to overseas enquiries. To date, this industrious entrepreneur has produced over 100 000 units and is actively looking for partner organisations with which to promote this initiative.

3G MEDICAL

HOSPITAL CURTAINS RESISTANT TO BACTERIAL GROWTH

With technical and regulatory assistance from the CSIR, a small local company successfully developed hospital curtains resistant to bacterial growth. These curtains play a crucial role in mitigating the spread of harmful pathogens, thereby safeguarding the wellbeing of patients, healthcare workers and visitors alike.

Based in KwaZulu-Natal, 3G Medical is a supplier and maintenance agency for medical devices and equipment. The production of bacteria-resistant hospital curtains can have a

SCAN TO WATCH THE VIDEO STORY



| Circumcision healing brace.



| A healthcare worker installs a sheepskin rug to help distribute body weight evenly and increase comfort.



| Preparation of sheepskin rugs at African Merino Trading.

significant impact on infection control measures within healthcare settings.

By providing invaluable insights and offering guidance on industry compliance, technical file compilation, the CSIR empowered the SMME to realise its vision. 3G Medical is dedicated to improving infection control in healthcare facilities through the development of disposable hospital curtains. Its focus on creating a product that can be easily replaced to maintain a sterile environment addresses a critical need within the healthcare industry for effective and manageable infection control solutions.

Additionally, 3G Medical has received assistance in various ISO 13485:2016 and manufacturing aspects of the company's product development.

The result is a product that not only enhances infection control protocols, but also sets higher standards for quality and safety in healthcare facilities.

AFRICAN MERINO TRADING

MEDICAL SHEEPSKIN RUGS THAT PREVENT BEDSORES

The CSIR is providing regulatory assistance to an SMME specialising in medical sheepskin rugs to prevent bed sores in critically ill patients.

These rugs serve as a soft, dense supportive layer placed on top of mattresses. Their purpose is to distribute body weight evenly, reducing pressure points and improving blood circulation to help prevent the development of bed sores. Moreover, these rugs offer warmth, absorb moisture and are reusable – a sustainable and effective solution for patients who are immobilised or have specific medical needs.

Mathebula highlights the significance of supporting these local medical device innovators. "Their solution has the potential to enhance patient comfort and care, particularly for vulnerable populations, and this aligns with the CSIR's strategy to foster technology solutions that address pressing healthcare challenges in the country."

South African merino skins are renowned for their fine fibre, great density and light, soft pelts.

In an initiative under the MeDDIC programme, the CSIR facilitated discussions with SAHPRA to classify the African Merino Trading product as a medical device and outlined technical requirements, including quality management system processes.



| Hospital curtains resistant to bacterial growth.

This support is intended to assist the company in obtaining the necessary licences to manufacture and distribute innovative sheepskin rugs as medical devices, expanding their customer base to include public and private hospitals.

"The concept behind African Merino Trading's medical sheepskin rugs may appear straightforward, yet it is revolutionary for patient care," says the founder of African Merino Trading, Simo Simov.

"Producing our medical sheepskin rugs relies on a blend of traditional craftsmanship and modern technologies to meet healthcare requirements, and with this assistance, it will enable us to scale our operations and reach more patients in need," he says.

ENQUIRIES:

>> **Tiyani Mathebula**
tmathebula@csir.co.za

>> **Kahesh Dhuness**
kdhuness@csir.co.za



The CSIR's 200-metre test tunnel, used for recreating full-scale coal dust explosions, was crucial in helping prove that a product of local SMME ExploSpot Systems can mitigate methane gas and coal dust explosions.

SMME TESTS ITS EXPLOSION SUPPRESSION SYSTEMS AT THE CSIR

Explosions are a serious hazard in underground coal mines and a risk to South Africa's zero-harm quest. The CSIR's mine fire and explosion testing and training facility provided the perfect technical setting to test a new range of systems for fire and explosion detection and suppression for Explospot Systems(Pty) Ltd.

The CSIR works with various SMMEs to enhance technologies, methodologies and operations in the mining industry. The organisation has capabilities, resources and facilities of value to SMMEs that produce mining and related products and services.

ExploSpot Systems (Pty) Ltd, a South African original equipment manufacturer that specialises in fire and explosion mitigation, contracted the CSIR to conduct a series of tests at its Kloppersbos mine fire and explosion testing and training facility.



The Explospot active suppression system installation in the CSIR's 200-metre tunnel.

The CSIR facility is well-positioned to allow large-scale coal dust and methane explosions for research, development and training purposes.

ExploSpot Systems has developed systems for automatic fire detection, automatic explosion detection and suppression, among other products. It is the only enterprise of its kind worldwide to have developed and industrialised an ultra-fast, effective and reliable explosion suppression system to stop methane and coal dust explosions. The system, called the Active Explosion Barrier, adheres to the protocols of the Safety in Mines Research Advisory Committee.

Assisted by CSIR experts, ExploSpot Systems conducted a sequence of tests on its explosion suppression system. These tests aimed to determine the system's effectiveness in stopping the propagation of methane-initiated coal dust explosions in the 200-metre gallery at the CSIR facility at Kloppersbos. The test protocol for the applied set of evaluations was adopted from the established CSIR practice and played a crucial role in the project's success.

The facility testing methodology also defined the test used to evaluate the performance of the suppression systems that stop dust explosions in underground coal mines. The methodology further stipulated the kind of data that had to be collected and the type and strength of the explosion to yield the required results.

The products tested by ExploSpot Systems prevented all explosions from propagating beyond the installation position of its active explosion barrier. The results proved that the barrier is fully functional in its configuration, irrespective of the static or dynamic pressure of the range of explosions included in the established CSIR test protocol and that it can mitigate any methane gas or coal dust explosion in an underground mine.

Chief executive officer at ExploSpot Systems, Arend Späth, says, "The CSIR team was highly skilled and motivated to prepare, conduct and analyse each test conducted at Kloppersbos. The unique knowledge and background of methane gas and coal dust explosions in South Africa is the reason why testing and test-reporting are acknowledged by South African and international inspectors and mining companies. While there might be other small-scale testing facilities available, the CSIR facility is currently the only facility acknowledged by our global customer base. It provided ExploSpot Systems with an opportunity to do the necessary functional and compliance testing that will ultimately protect workers and assets locally and abroad."

Isaac Mthombeni, CSIR testing and training supervisor, says, "The CSIR acknowledges the importance of collaborating with SMMEs in the mining sector. Ultimately, these collaborations contribute to the creation of jobs, stimulate the economy and improve mining operations."

"Working with ExploSpot Systems was an exceptional experience – the team is dedicated, result-driven and committed to teamwork. Seeing them get the desired results from the tests provided us with almost as much satisfaction," he says.

ABOUT THE CSIR FIRE AND EXPLOSION TEST FACILITY

The CSIR fire and explosion test facility at Kloppersbos, north of Pretoria, comprises a range of test and research and development facilities, some of which are unique worldwide. At the heart of its operations is a commitment to conducting full-scale surface tests for fires and explosions in a controlled environment, overseen by experienced staff. The safety training is designed to reinforce awareness among underground workers of the dangers associated with methane and methane/coal dust mixtures in an underground environment, as well as those associated with hard rock mining, such as gold and platinum mining. Miners receive training on best practices for preventing potential dangers and how to deal with dangerous conditions underground. Demonstrations are conducted in the 10m and 200m tunnels, as well as the ventilation tunnel.

ENQUIRIES:

>> **Isaac Mthombeni**
imthombe@csir.co.za

The combined flight test team from local SMMEs Sysdel (left) and Sovereignty Systems (right), with the CSIR, in front of a BAE Hawk Mk120 aircraft. The fast jet is carrying Sysdel's new ACEPOD Mk2. The CSIR supported the design, integration and testing of the pod together with the South African Air Force, thereby capacitating the two SMMEs to compete in the global aerospace industry.

SCAN TO WATCH THE VIDEO STORY



A NEW DEFENSIVE POD TECHNOLOGY FOR FAST JETS

Local engineering SMMEs, Sysdel and Sovereignty Systems, have joined the exclusive club of entities that have successfully developed and flown stores on a very demanding fast-jet combat aircraft. The companies joined CSIR engineers for flight tests of a new defensive pod they designed, integrated and tested with the technical support of CSIR aerospace experts.

In March 2024, a South African Air Force (SAAF) BAE Hawk Mk120 fast jet took to the skies near Cape Agulhas, carrying a new, locally developed technology that could help aircraft defend against attacks.

These flight tests were the culmination of work that began in 2019 when Armscor tasked the CSIR to assist local small business Sysdel CC with integrating its new pod with the Hawk aircraft.

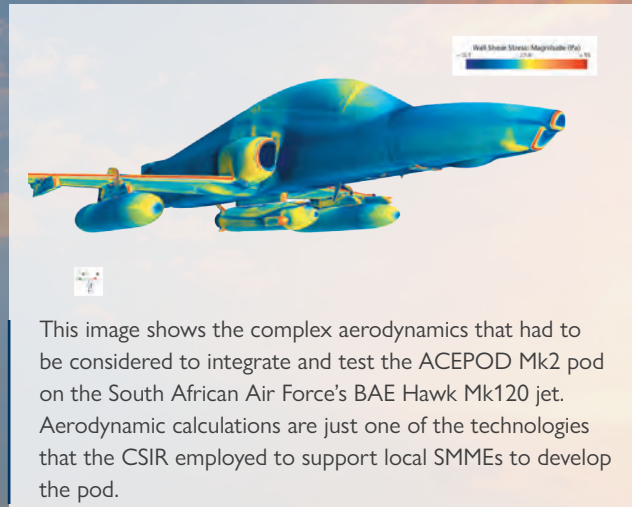
The CSIR's aerospace experts were commissioned to lend their decades of aeronautical research and development experience in the fast jet environment, which was a novel challenge for the SMME.

"We helped them to develop something that would be safe to fly in a very challenging combat aircraft environment," says Kevin Jamison, veteran aeronautical engineer and aircraft store integration specialist at the CSIR.

He says the CSIR has contributed to a range of technologies since 2019, and testing is ongoing.

"We have a powerful computer cluster, which we use for calculations called computational aerodynamics," says Jamison, adding that this project required extensive computational fluid dynamic calculations. This essentially entails predicting how travelling at speed through air or liquid would affect the forces on an aircraft or pod.

The South African Air Force's BAE Hawk Mk120 captured during a flight test at Air Force Base Overberg in the Western Cape. Engineers from the CSIR and two local SMMEs fitted the aircraft with the new, proudly South African ACEPOD Mk2. Image courtesy: Ruan du Rand.



This image shows the complex aerodynamics that had to be considered to integrate and test the ACEPOD Mk2 pod on the South African Air Force's BAE Hawk Mk120 jet. Aerodynamic calculations are just one of the technologies that the CSIR employed to support local SMMEs to develop the pod.

The CSIR team further supported the SMME with engineering analyses. “We did ground vibration testing and flutter analysis, and we supported them with fit checks at the air force base,” says Jamison. “We also assisted with specifications for the aircraft integration, describing the flight environment and safety checks.”

Sysdel CC also subcontracted a youthful team from a local black-owned SMME Sovereignty Systems for additional engineering support on the project.

Once the pod was successfully integrated onto the aircraft, the CSIR facilitated the March flight test at the SAAF's Test Flight and Development Centre at Air Force Base Overberg, near Cape Agulhas.

“We used this opportunity to expose young engineers to fast jet flight testing, which is a real privilege that seldom comes along nowadays,” says Jamison. These young engineers have recently completed their store integration courses offered by the CSIR and a company called Midnite Aerospace Solutions.

The new, proudly South African ACEPOD Mk2 was unveiled to the public at the Africa Aerospace and Defence Expo in September 2024.

“This pod is the largest store ever integrated on the centreline of the Hawk anywhere in the world,” says Jamison, adding that the CSIR has applied for a patent for the integration process to protect South Africa's strategically important ability to integrate stores with aircraft independently of original equipment manufacturers.

The next phase of flight and ground testing to prove the technological capabilities of the pod is expected to be completed early in 2025.

Jamison says the partnership between the CSIR and these two SMMEs is ultimately a story about capacity building.

“Sysdel and Sovereignty Systems can now be key players in terms of developing pods for fast jet aircraft, and we look forward to seeing the next generation of flight test engineers at work.”

ENQUIRIES:

>> **Kevin Jamison**

kjamison@csir.co.za



Representatives from six engineering firms attended wind tunnel training at the CSIR in 2023. They now have a better grasp of the CSIR's experimental capabilities, which could assist them with store integration projects for their clients.

AEROSPACE SKILLS TRAINING FOR SMMEs

The CSIR's expert aeronautical engineers provided hands-on training to several SMMEs during 2023.

"With this training, we want to support local SMMEs to grow into world-class aerospace enterprises that can compete globally to the national benefit," says Bhavya Vallabh, the business development manager for the CSIR's Aerospace Systems group.

She says project managers, systems engineers, flight test engineers and specialist engineers from aerospace and defence company Incomar completed a four-week advanced course in aircraft store integration. The course was presented by CSIR head engineer Kevin Jamison, who drew on his 30 years of experience integrating pods, missiles and other stores onto aircraft.

"The course covered topics such as planning and executing a store integration project and airworthiness aspects of store integration, including systems integration, carriage integration, carriage environment, aeroelasticity and flutter, loads and structural integrity, separation and jettison, aircraft performance and handling, and flight testing," says Jamison.

The engineering capabilities and expertise needed to analyse and assess the technical aspects of store integration are all available at the CSIR.

Aerial and Security, TMI Simulation Services, Technostar Engineering and Digix Computers CC were also exposed to the

CSIR's wind tunnel suite, with a one day lecture on the basics of wind tunnel testing. The lecture was presented by CSIR principal researcher Mauro Morelli.

"This facility has been generating experimental data for the aeronautical establishment in South Africa and internationally for over 50 years," says Morelli.

The SMMEs learnt about the type of data that can be acquired from a wind tunnel experiment, and how this might be applied to aircraft design and aircraft store integration.

"These training courses will enable the SMMEs to have a broader understanding of the capabilities available in the CSIR's aerospace competencies, which will help them be competitive nationally and internationally," he says.

Vallabh adds that the SMMEs should see growth as these new skills will enable them to attract new clients and deliver more services.

The development of these SMMEs in experimental aerodynamics and store integration will in future benefit the CSIR by enabling a capable local aerospace industry.

ENQUIRIES:

>> **Kevin Jamison**
kjamison@csir.co.za

PHONE-CHARGING WINDOW BLINDS TESTED AT CSIR FACILITY

Local technology company LC Dynamics seeks to drive positive change in the renewable energy sector with its innovative solar blinds. The CSIR assisted the SMME with baseline power measurements and electro-luminescence imaging as part of an enterprise development initiative of SAICA Enterprise Development (SAICA ED), called the EneGro programme.

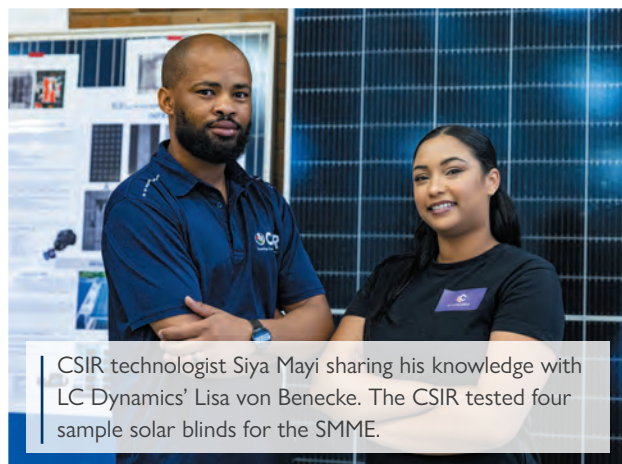
In a world increasingly conscious of sustainable energy solutions, innovative minds like Lisa von Benecke are leading the charge towards a brighter, more environmentally friendly future. Von Benecke, a mentee under the SAICA ED EneGro programme, is not only harnessing her business, finance and electrical engineering expertise but also pioneering a groundbreaking product, a solar photovoltaic (PV) window blind, through her company, LC Dynamics.

The EneGro programme provides customised incubation, aimed specifically at developing a network of black SMMEs in the energy sector in South Africa. Over the years, the CSIR has partnered with SAICA ED as industry experts, providing technical assistance to the participating SMMEs.

LC Dynamics has developed solar blinds that serve as plug-and-play backup power sources for critical devices and lights. With a vision to obtain certification for the product, LC Dynamics is committed to revolutionising the renewable energy landscape in South Africa for users who cannot install full solar systems but who also want to be shielded from the negative impacts of loadshedding.

The CSIR, through the EneGro programme, provided technical support to LC Dynamics for the testing of four sample solar blinds at the CSIR's PV module quality and reliability testing laboratory. This laboratory is the first of its kind in Africa and boasts world-class equipment localising accelerated reliability stress testing on PV modules. This ensures that only high-quality modules suitable to the unique South African climate are developed and installed.

The CSIR team conducted baseline power measurements under standard test conditions using the A+A+A+ rated sun simulator and electroluminescence imaging. Electroluminescence images reveal defects in solar cells that are invisible to the naked eye. The tests provide a reference point and determine that the solar cells meet specified ratings and perform as expected.



CSIR technologist Siya Mayi sharing his knowledge with LC Dynamics' Lisa von Benecke. The CSIR tested four sample solar blinds for the SMME.



A site visit to the CSIR solar PV installations and PV testing lab provided Von Benecke with practical insights and hands-on learning opportunities, enriching her entrepreneurial journey.

ENQUIRIES:

>> **Wisani Mkasi**

hmkasi@csir.co.za

Workers at Mezé Foods can work uninterrupted following the installation of solar power at the SMME.



SMALL BUSINESSES IN GAUTENG SUPPORTED TO SWITCH TO SOLAR

Several small businesses in Gauteng, including popular Mediterranean dip-maker Mezé Foods, are now running on solar power. Thanks to a government programme supported by CSIR energy experts, 17 SMMEs received solar panels, an inverter and batteries, and they report lower electricity costs and fewer interruptions due to loadshedding.



Several small businesses in Gauteng, including food producer Mezé Foods, are now running on solar power thanks to a government programme supported by CSIR energy experts.

South Africa's National Cleaner Production Centre (NCPC), which is hosted at the CSIR, supported 17 enterprises as part of a Gauteng provincial government programme to implement alternative energy solutions for SMMEs in the province.

The programme, known as the Green Incentive Support Programme, was funded and initiated by the Gauteng Department of Economic Development (GDEP). The department approached the NCPC to provide technical support and solar photovoltaic (PV) systems to selected SMMEs over two years ending in April 2024.

The companies were from a variety of sectors and were selected following an open call for expressions of interest.

The NCPC assessed the energy contexts of SMME applicants, made recommendations and implemented energy improvements. In total, energy audits were conducted in 30 facilities, assessing their energy needs and the feasibility of alternative energy solutions. Some 24 facilities met the requirements for alternative energy installation, with 17 companies ultimately remaining in the project to receive solar photovoltaic systems.

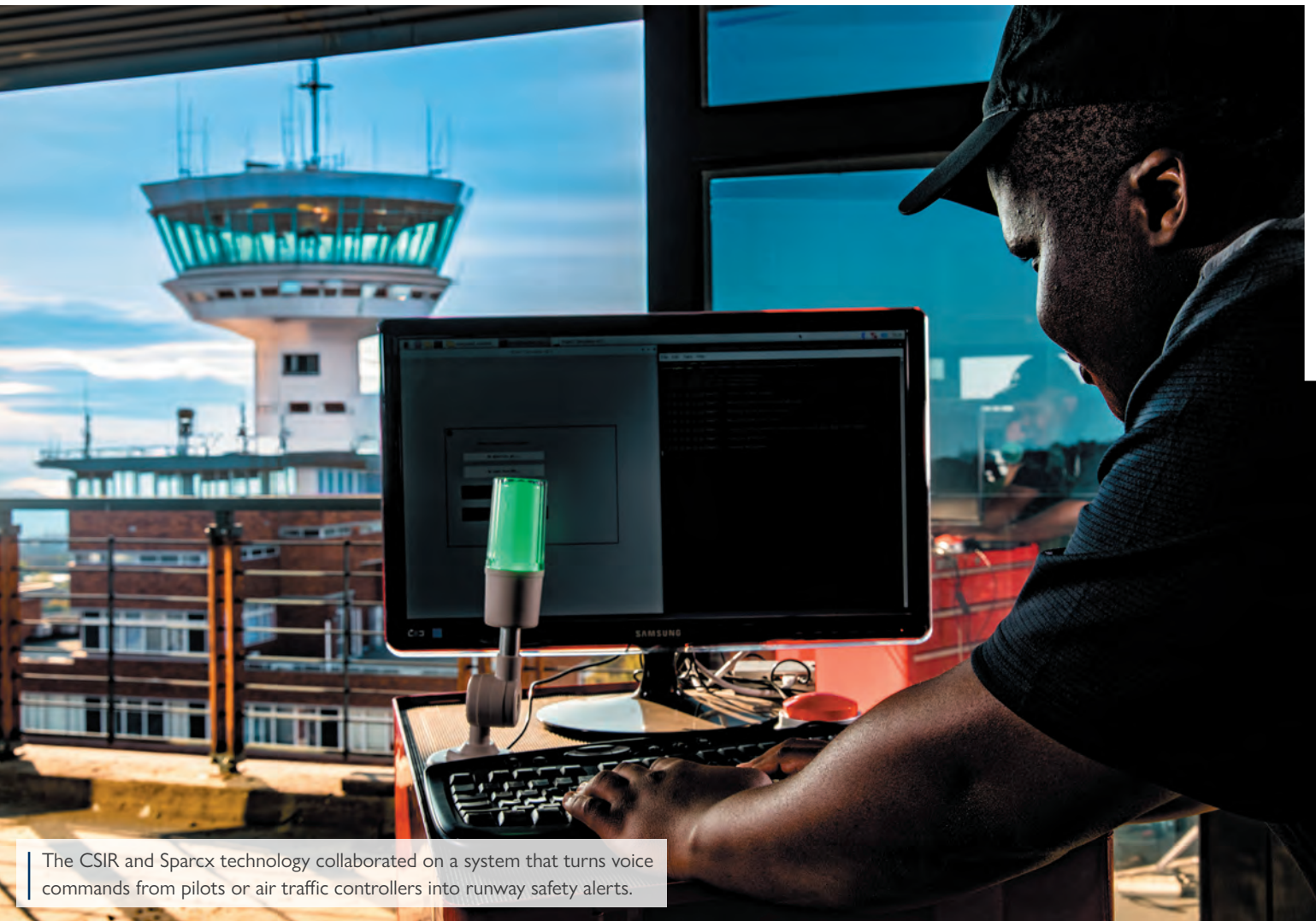
One recipient, Mezé Foods, applied to the programme to escalate the adoption of sustainable practices at their manufacturing plant in Daleside in Gauteng. Mezé Foods produces a range of food products including cheeses, dips, pestos, olives and bakery products.

Mezé Foods had undergone an energy assessment in 2021, which made them eligible for the Gauteng Green Support Incentive Programme. The company had already made significant energy efficiency improvements, including 23 MWh demand reduction through compressed air system optimisation. Between them, the 17 SMMEs were provided with approximately 385 kWp of generation capacity, with systems including solar panels, three-phase inverters and lithium batteries. The CSIR Energy Research Centre is conducting follow-up inspections at the sites to ensure the systems are adding value, but preliminary results show that the companies are already benefitting from decreased electricity costs and a buffer against loadshedding.

ENQUIRIES:

>> **Julie Wells**

jwells@csir.co.za



The CSIR and Sparcx technology collaborated on a system that turns voice commands from pilots or air traffic controllers into runway safety alerts.

SAFER RUNWAYS WITH AI THAT UNDERSTANDS SOUTH AFRICAN ENGLISH

A new model of the CSIR's speech recognition technology, which understands South African English, could soon help air traffic controllers at busy local airports. The model was jointly developed by the CSIR and Sparcx (Pty) Ltd. It feeds into a Sparcx artificial intelligence system that turns voice commands from pilots or air traffic controllers into runway safety alerts.

What does "cleared to land" sound like in South Africa? The answer is that it depends on the English accent of the air traffic controller, as their first language might be any of South Africa's 11 official written languages.

The CSIR and local SMME Sparcx have jointly developed a proof of concept for a new system that helps detect and alert air traffic controllers to potential airport runway incursions.



The team, from left, Franco Mak, CSIR researcher; Octavia Mdluli, Sparcx Project Administrator; Sujo Mulamattathil, Managing Director; Privolin Naidoo, CSIR senior researcher; Dr Avashna Govender, CSIR research group leader for voice computing; and Moorosi Motake, Lead Design Engineer from Sparcx.

"This system processes voice commands by pilots or air traffic controllers, converting them into actionable data," says Dr Avashna Govender, CSIR research group leader for voice computing.

She says the system could add a new layer of safety information to supplement ground-based radar and visual observations.

"With the additional layer of safety, especially for the high-stress environments of air traffic control, the system will validate that the air traffic control commands will not cause an incursion," explains Sujo Mulamattathil, CEO of Sparcx.

In Africa generally, the complexity of ensuring safe take-offs and landings is increasing every year: runways are busier due to increasing volumes of passenger and cargo planes; unpredictable or severe weather events due to climate change can interfere with safe landings; and new forms of airborne vehicles, like drones, demand airspace.

Air traffic controllers and pilots are forced to lean on modern technologies like artificial intelligence (AI) to navigate this complexity. Unfortunately, says Govender, many existing AI systems struggle to recognise South African English accents.

"Our system is specifically tailored to the South African context, as the automatic speech recognition unit is designed to handle South African English accents that many existing automatic speech recognition units fail to capture effectively," she says.

The new runway occupancy alerting system will be designed to detect and alert air traffic controllers of potential dangers on the runway.

"We are thrilled to partner with the CSIR to develop indigenous technologies, build local skills and expertise and exploit indigenous intellectual property," says Mulamattathil.

"The CSIR's voice computing team was exceptionally knowledgeable in the domain of voice computing and proved to be a perfect partner to develop the proof of concept," he says, "which enabled Sparcx to deliver a solution at technology readiness level 6 to our client."

While the proof of concept is still a work in progress, the longer-term vision is to progress to an industrialised and qualified technology that can effectively operate in real-world air traffic control towers by processing live input streams in real time.

Govender says the collaboration with Sparcx is a research, development and innovation outcome with enormous potential for safer aviation in the country, and the technology could take off quickly from here.

"Beyond aviation, these technologies hold immense promise in sectors such as healthcare, finance and customer service. By semi-automating repetitive tasks, enhancing data analysis capabilities and improving decision-making processes, businesses can unlock new efficiencies, increase quality, improve safety and drive growth."

SPARCX (PTY) LTD.

Sparcx is an electronic engineering firm building products and integrating solutions in the defence, aerospace and public safety domains. Sparcx can design, develop, industrialise and commercialise products from idea to commercial operations.

ENQUIRIES:

>> **Dr Karen Calteaux**
kcalteaux@csir.co.za



WESTERN CAPE FIREFIGHTER DRONES TO USE CSIR SENSORS

Table Mountain authorities in the Western Cape may soon call on firefighter drones to detect and extinguish small fires in hard-to-reach places before they spread to the City of Cape Town. In March 2024, the CSIR exclusively licensed its K-Line fire sensor to a local company, Autonosky, which designed their Autono1 drone to drop fire-retardant balls on small-scale blazes.

“Autonosky specialises in extinguishing small-scale fires, but before partnering with us, they did not have the ability to detect, track and estimate the spread of small-scale fires,” says CSIR senior engineer Edwin Magdimisha. “We introduced the Autonosky team to the concept of fire dynamics and we

collaborated with the company to jointly test their K-line payload for fire detection.”

His team worked with Autonosky’s engineers to integrate the sensor onto the Autono1 drone using Autonosky’s specialised



SMME Autonosky has integrated the CSIR’s K-line technology onto their firefighting drone (far right). They will now be able to detect, track and predict the spread of small-scale fires in real time, both onboard and on the ground via streaming.





SCAN TO WATCH THE VIDEO STORY



gimbal, and the CSIR provided the operational requirements for using the sensor to geo-locate and monitor fires in real time.

“We also showed them that not only can you stream information to the ground for post-processing, but you can actually do onboard image processing in real-time,” says Magidimisha. This means the ground station will receive processed fire-detections instead of raw data.

He says the combination of fire-sensing and firefighting payloads now fitted onto the drone could prove invaluable during the Western Cape’s hot and windy fire season.

“In mountainous areas, one would find it very hard to drive a fire truck towards a fire, and helicopters require a lot of money

and time to organise,” says Magidimisha, adding that the risk to human life is high.

“In 2018, for example, we lost a pilot fighting wildfires in the Cape.”

That same year, the K-line camera technology began detecting wildfires from space on board South Africa’s ZACUBE-2 satellite.

It is named for its ability to detect potassium (K) emitting light energy from combusting vegetation. It can pick up the tell-tale signs of a fire at a very particular point, or line, on the electromagnetic spectrum, namely the 770 nm line. This line is still within the visual light spectrum but is near where the infrared spectrum begins.



“We were the first in the world to launch such a payload,” says Magidimisha. Even back then, his team saw the potential of the K-line camera to assist with forest disaster management efforts closer to the ground.

He says that infrared sensors have traditionally been used for fire detection. “Unfortunately, these sensors register any high-radiating source as a potential fire, and they are costly,” says Magidimisha. “They require cooling for accurate detection and are prone to false detections.”

In contrast, the near-infrared K-line sensor is flaming specific, he explains. This means it has few false positive readings, and since it does not require heavy cooling equipment, it is ideal as a light payload for satellites or drones.

He adds that although no person wants a fire to break out in the windy hotspots of the Western Cape, Autonosky is already engaging with potential clients to deploy their K-line-fitted drone.

“Drones can safely and quickly access areas that may be too dangerous or inaccessible to firefighters,” he says. Putting out small-scale fires before they spread or become out of control is critical to preventing catastrophic damage to property and the loss of human life.

Magidimisha says he wants to assure other SMMEs that there are many more commercial opportunities waiting to be unlocked with the K-line technology, especially considering South Africa’s booming space industry and the fact that wildfires are becoming more frequent and disastrous due to climate change.

According to Simphiwe Mkwelo, CSIR impact area manager for optronic sensor systems, the K-line technology can be integrated into space satellite observation systems for global wildfire surveillance, fire monitoring systems for unmanned aerial vehicles (UAVs) used in tactical firefighting and ground-based systems on elevated platforms.

“The K-line UAV technology will be a game changer in the toolset of firefighters as it will reduce the cost of firefighting significantly. It also ensures access to hard-to-reach places and provides fire spread dynamics that will help with tactical decision-making,” says Mkwelo.

AUTONOSKY

The CSIR has licensed its K-line fire detection technology to Autonosky, an SMME based in the Western Cape. Autonosky supports the Western Cape Fire Emergency Services with drone technologies that can go where human responders cannot. Their drones are optimised to extinguish small-scale fires by dropping fire-retardant balls. By adding the CSIR’s K-line camera to their payload, they will be able to detect, track and predict the spread of small-scale fires in real time, both onboard and on the ground via streaming.

With the tagline, “aerial technology solutions”, Autonosky’s CEO, Amit Ramdath, says the company leverages breakthroughs in artificial intelligence and robotics to drive innovation in aerial systems that assist rescue, fire and security organisations.

THE CSIR’S K-LINE FIRE DETECTION TECHNOLOGY

The CSIR’s K-line technology is an optical imaging system that uses remote sensing techniques to detect potassium light energy emitted from burning vegetation during the combustion phase of fires.

Potassium, a chemical element with the periodic symbol K, is released as light energy from fires and can be easily isolated using silicon-based detectors with peak sensitivity within the near-infrared spectrum, specifically the 770 nm line. This technique has proven valuable for developing compact, affordable remote sensing systems for ground and airborne fire detection.

The K-line camera is more precise and timelier than conventional cameras in measuring fire flame location and spread dynamics due to its small pixel size, high pixel sensitivity and fast pixel response.

ENQUIRIES:

>> **Edwin Magidimisha**

EMagidimisha@csir.co.za

LOCAL FIRM'S CYBERSECURITY ACADEMY UPSKILLS YOUTH

The Cyber Excellence Academy, launched in 2023, prepares young people to work in the cybersecurity industry. The CSIR supported cybersecurity firm Take Note IT to establish the academy, which aims to help reduce youth unemployment by helping youngsters further and fund their education after matric. Four of the academy's graduates have so far secured internships at the CSIR.

The Cyber Excellence Academy is an intensive training programme designed to equip participants with industry-leading expertise in cybersecurity. By fostering a deep understanding of cybersecurity principles, strategies and best practices, the academy aims to produce a new generation of highly skilled professionals who can proactively safeguard organisations against ever-evolving cyber threats.

This programme focuses on the youth, specifically females and unemployed youth at the matric level.

"It has become clear to us that many young people with matric or higher education certificates struggle to either go to university or enter the job market despite having great potential," says CSIR Defence and Security Executive Manager, Siphon Mbhokota. "This programme contributes to skills development and on-the-job training for these young people."

He says the CSIR partnered with an SMME called Take Note IT to establish the academy in 2023, citing the industry experience built up by the enterprise since its formation in 2007.

"We supported the SMME with interviewing the students and purchasing cyber range licenses for 10 students. We also contributed to the curriculum of the students and supported both the launch and graduation of the students," says Muyowa Mutemwa, CSIR research group leader for data security and analytics.

"What makes this programme stand out is that it provides an opportunity to empower the youth with skills while equipping



| The first graduates of the Cyber Excellence Academy.

them with work experience, all in a short space of time," says Mbhokota. "The programme unlocks opportunities to build individuals' skills in a valuable, sought-after field. With the focus, resilience and diligence of the teams involved, impact is guaranteed."

The academy's commitment to fostering excellence and innovation in cybersecurity education was recognised during the State Information Technology Agencies' GovTech conference in 2023 when the programme won the "Community Builder Recognition Category" award.

In April 2024, a graduation ceremony for the first graduates of the Cyber Excellence Academy took place at the CSIR International Convention Centre.

Take Note IT CEO Mamele Luthuli said, "The CSIR's extensive experience and expertise in cybersecurity, coupled with Take Note IT's track record of delivering high-quality IT solutions, create a unique and powerful synergy to provide participants with an unparalleled learning experience."

During the programme, the students visited the CSIR to gain industry exposure within the organisation's Virtual Security Operations Centre.

Five of the first cohort of students were granted on-the-job experience at the CSIR's Information and Cybersecurity Research Centre. They will deal with real-life cybersecurity issues and threats and will learn first-hand how to conquer cybersecurity challenges.

TAKE NOTE IT

Founded in 2007, Take Note IT is a leading provider of innovative IT solutions and services. With a focus on cybersecurity, cloud computing and digital transformation, Take Note IT empowers organisations to achieve their goals and thrive in today's digital landscape.

ENQUIRIES:

>> **Muyowa Mutemwa**
mmutemwa@csir.co.za

WHERE IS THE BEST PLACE FOR AN AUTOMATIC SUNFLOWER OIL DISPENSER?

With almost 60 smart cooking oil refill machines already installed in grocery shops across Southern Africa, Sonke Retail's idea of bringing together plastic recycling and affordable refills is catching on quickly. While the company focuses on building machines and keeping customers happy, CSIR engineers are analysing consumer refill patterns to help Sonke streamline existing installations and identify new store locations.



Sonke Retail (Pty) Ltd. and the CSIR team at a new installation of Sonke's cooking oil refill station at a grocery store. Consumers pay a flat rate per litre and are able to dispense the oil into their own containers. The CSIR analyses consumer refill data collected by the machines on-site to help the SMME grow. From left, Carla Beetge and Carike Karsten (CSIR), David Monametsi and Elias Maake (Sonke), and Paul Burger (CSIR).

“Cooking oil comes at a premium when you buy it in smaller pack sizes,” says CSIR senior engineer Carike Karsten.

She says South African shoppers pay nearly a 50% premium per litre for cooking oil when they buy the smallest available bottle (~375 ml) versus the largest one (5 litre). And after the last drop is used, the empty plastic container usually makes its way to a landfill, adding to an ever-growing pile of non-biodegradable waste.

The same pattern emerges across the full range of consumer-packaged goods, says Karsten, from foods like sugar, rice and maize meal to home care products like laundry detergents and dishwashing liquid.

Sonke Retail (Pty) Ltd. saw an opportunity within this dual dilemma: what if shoppers could fill their containers, big or small, priced at the best price point at a flat rate per litre?

“Their innovation is helping to reduce waste while at the same time empowering people who do not have the disposable income to buy larger pack sizes. The innovation makes products affordable and more accessible for the most vulnerable in society,” says Karsten.

But what makes these refill stations particularly special is that each one is IoT-enabled. The units collect and send data to a live dashboard that improves operational efficiency through smart supply chain management.

Sonke has so far rolled out 57 refill stations to grocery stores serving low-income communities. But thanks to the smart nature of the machines, in-store applications could potentially range far beyond cooking oil.

Karsten says that since the enterprise is spending its time and resources to build new machines, launch new store locations and ensure customer satisfaction, they approached the CSIR in 2023 to help with analysing their data.

Because the business is grounded in the idea of reusing plastic containers instead of throwing them away, the CSIR was able to secure a grant from the Circular Economy Demonstration Fund to support Sonke Retail with market and operational research.

“We are now looking at the backend to see where these machines are most successful and why, for example, one machine is more successful than another in a shop just two kilometres away,” she says.

Karsten’s team provides SMMEs like Sonke with expertise in data analysis, statistics, industrial engineering and software coding. She

says they work on projects concerned with the future of cities and how to plan and prepare for them through next-generation technologies.

As in the case of Sonke, Karsten’s team can advise entrepreneurs on using smart technologies to optimise and grow their businesses.

One interesting insight they have uncovered in Sonke’s sales data is that shoppers appear more hesitant to use the refill machine if the store does not already stock the SunQueen brand of cooking oil.

“If SunQueen is on the shelves in the store, it’s more likely that the machine will be used because there is a recognisable product nearby. The price to refill is also clearly more competitive than smaller shelf products as the machine has a fixed rate for any amount of oil,” says Karsten.

“In the next couple of months, we’ll finalise these in-depth analyses and then determine what factors Sonke should use to decide in which areas to locate their machines,” she says, adding that the project will conclude in 2025.

Karsten says the support provided to Sonke demonstrates the CSIR’s role in helping small businesses innovate. Whether a business is struggling with a production process, the flow of information or finding its target market, the CSIR can assist with scenario planning, running simulation models and even developing custom online tools, she says.

SONKE RETAIL (PTY) LTD.

Sonke Retail (Pty) Ltd. is a technology start-up that designs, manufactures and manages internet of things-enabled automated refill stations. Sonke’s proprietary backend software provides full traceability of stock movement through the supply chain, from receipt through dispatch, machine restocking and sale to the shopper. Sonke refill stations eliminate up to 100% of single-use plastic packaging and allow up to 50% shopper savings by enabling fixed rand per litre pricing across all refill sizes.

ENQUIRIES:

>> **Carike Karsten**
ckarsten@csir.co.za



From left, Tarlia Sooman, Matlala Group Head of Operations; Dr Keith Ferguson, CSIR chief engineer; Abbey Matlala, Matlala Group Managing Director; Dr Hlabishi Kobo, CSIR research group leader for cloud, network architectures and services.

LOW-COST VIDEO STREAMING FOR AFRICAN MARKETS

A cloud streaming technology that works better in Africa's limited internet environment was licensed from the CSIR by local SMME Matlala Group in March 2024. The CSIR began assisting the company with developing and customising the technology in 2022, with the goal of delivering unbroken video streams at lower cost over mobile networks.

In 2022, the CSIR signed a co-development agreement with the Matlala Group aimed at taking the CSIR's next-generation cloud streaming offering to market. The vision was to jointly develop the cloud streaming product with a commercial partner using a two-pronged approach of early commercialisation, and further technical development and customisation to meet user needs.

The next-generation cloud streaming technology is a distributed cloud-based adaptive video content distribution solution. It consists of a content brokering service, live video encoder, video

file encoder, dynamic micro content distribution node, video transcoder and a stream multiplier as main components. It takes advantage of some of the emerging distributed computing functions in container cloud design.

The CSIR next-generation cloud streaming technology builds upon an internationally patented solution that delivers unbroken video streams over the internet, including mobile networks from 2.5G (rural) to 5G, at data costs ranging from as low as R2 up to R50 per viewing hour for an average mobile package.



The solution has a low barrier to entry and is packaged into an offering as 'broadcasting in a box', suitable to enable media and SMMEs to become global broadcasters.

By mutual arrangement, the co-development agreement of this technology would be transitioned into a full licence agreement with full commercial and financial obligations within a period of 12-18 months. The full commercial licence was signed between the parties in March 2024.

"The collaboration with the Matlala Group on this technology has enabled the CSIR to engage the market through an early commercialisation process, which in turn guided the research and development work on the salient areas the technology should address," says Dr Hlabi Kobo, CSIR research group leader for cloud and network architectures and systems.

"For Matlala Group, noting it is an SMME, research and development in the information and communications space is a critical path for any system integration business. Hence, the Matlala Group partnered with the CSIR and leveraged the skills and expertise of the CSIR team led by Dr Keith Ferguson," says



the Managing Director of the Matlala Group, Abbey Matlala. The key advantage of the technology is that it focuses on solutions for African (emerging) socioeconomic conditions, not catered for in the imported solutions currently in common use within South Africa. The core intellectual property is a novel distributed system of cloud streaming components and optimised rate adaptation algorithms that are more network-friendly.

"The collaboration with the Matlala Group on this technology has enabled the CSIR to engage the market through an early commercialisation process, which in turn guided the research and development work on the salient areas the technology should address. This collaboration demonstrated how bespoke research, development and innovation can be balanced with a valuable impact on society by supporting SMMEs," says Kobo.

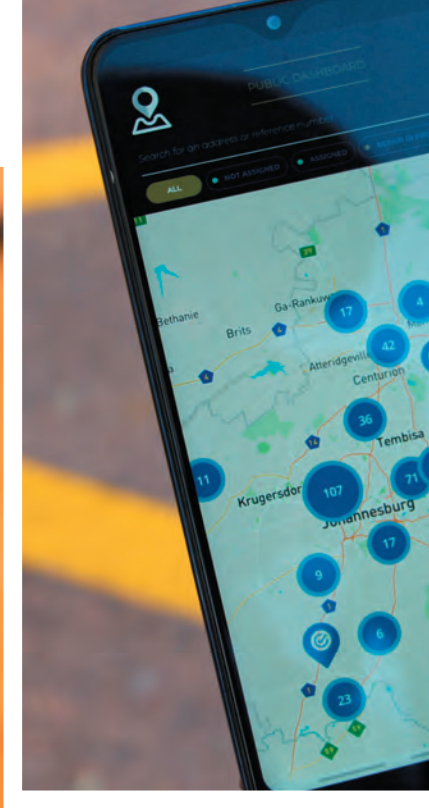
The CSIR and the Matlala Group collaborated on both technical and business development aspects towards positioning the technology as a revenue-generating offering.

"This is in progress and will provide a number of use cases to be leveraged for different markets as consumers of the technology itself," says Matlala.

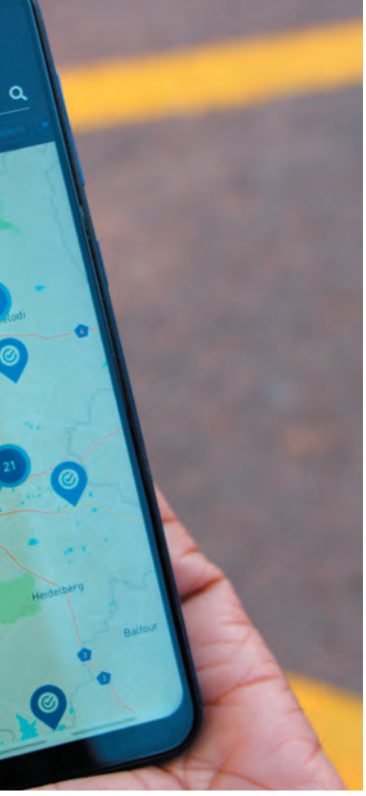
ENQUIRIES:

>> **Dr Hlabishi Kobo**

hkobo@csir.co.za



The CSIR joined forces with SMME ThinkNinjas to develop a mobile application (app) to streamline and digitise the reporting of road infrastructure maintenance issues such as potholes and traffic signal failures in Gauteng. Earlier, the SMME also assisted in developing of the Green Book (inset), which helps decision-makers with human settlement planning based on climate risk data.



NEW MARKETS FOR CODING FIRM THINKNINJAS

A climate risk app and a pothole reporting app for the government, both co-developed with the CSIR, have opened new markets for local software development SMME ThinkNinjas to grow into. This partnership is one where CSIR experts scope app requirements with its government partners and then contract ThinkNinjas to design and build the software.

When the Gauteng government urgently needed an app for people to report potholes, the CSIR called on the coders at ThinkNinjas to assist. Together, the CSIR and this SMME developed the PotholeFixGP app, which notifies the Gauteng Department of Roads and Transport (GDRT) when users upload pictures, locations and descriptions of potholes. Users can also report traffic signals that are not functioning.

“They are reliable and innovative, and we work well with them,” says CSIR principal researcher Michael Roux, adding that ThinkNinjas has become a trusted service provider.

As an experienced engineer in the municipal roads sector, Roux leads the CSIR’s road asset management support for the GDRT.

He says the CSIR continues to support ThinkNinjas as a small business because it delivers excellent work. “It’s a contract relationship – the CSIR has the domain knowledge and understands what the client needs, and then we work together with the company to develop web-based systems and mobile applications.”

Roux says the CSIR has also opened new markets for the SMME in the public sector, largely due to the state-owned entity’s close link with government departments.

He says the CSIR and ThinkNinjas worked together previously to develop the Green Book tool, which provides the South African government with municipal climate risk data for human settlement planning.

“We are also going to be working together on projects for the Gauteng Department of Infrastructure and Development and the Gauteng Department of Cooperative Governance and Traditional Affairs,” says Roux.

Martin Jansen, ThinkNinjas CEO, says the company adds value to the CSIR but that his small team of 22 developers and administrative staff are also honoured to be able to work with the CSIR to move technology forward.

“We are a proud South African company that works with the CSIR so that they can improve the lives of others,” he says. “

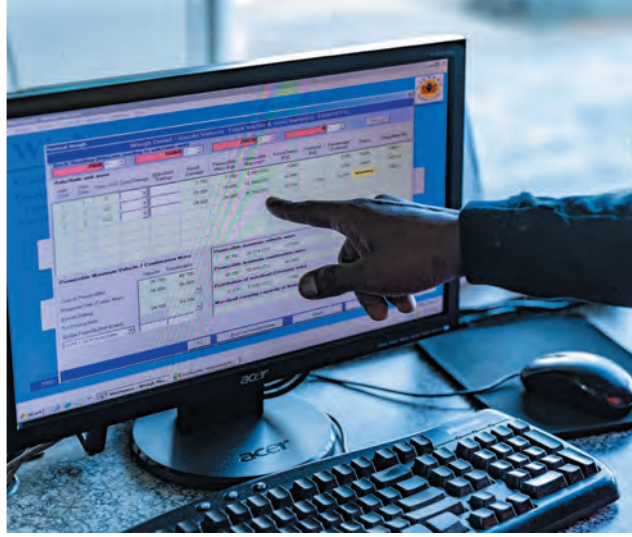
ENQUIRIES:

>> **Michael Roux**

mproux@csir.co.za



Weighbridge personnel use software called WinNuwei to determine whether a vehicle is overloaded. The software was developed by the CSIR and local SMME Datron.



SOFTWARE TO HELP AUTHORITIES TRACK OVERLOADED TRUCKS AT WEIGHBRIDGES

The CSIR developed a weighbridge management system called WinNuwei in partnership with software firm Datron, and licencing talks are underway. The system supports public road infrastructure by flagging overloaded heavy vehicles and exemplifies how the SMME leans on the CSIR's networks and technologies to expand its coding offerings for public infrastructure projects.

As part of its larger involvement in heavy vehicle overload projects and strategies, the CSIR worked with local SMME Datron to develop software for South Africa's provincial weighbridges.

A weighbridge is used to weigh entire road vehicles and their contents, allowing traffic law enforcement authorities to enforce load regulations. By preventing overloaded trucks from travelling on roads, road networks remain in a better condition for longer, road maintenance budgets are kept in check and the number of accidents caused by overloaded vehicles is reduced.

CSIR principal civil engineer Michael Roux says the software developed by the CSIR and Datron allows staff at weighbridges to easily determine when a vehicle is overloaded and issue fines.

Weighing data captured in WinNuwei is exported and analysed using the CSIR-developed Vehicle Overload Management System, enabling the CSIR to produce monthly and annual vehicle load control reports for law enforcement authorities.

"We worked with Datron to develop the system, which is called WinNuwei," says Roux, adding that the company is also responsible for the maintenance and support of the system. Together, they installed the software at weighbridges across South Africa, including in KwaZulu-Natal, Limpopo, Gauteng, the Free State and the Western Cape, as well as in Mozambique.

The CSIR and Datron also trained weighbridge personnel to use the software, which was designed to be user-friendly. "The system must be easy to use and take into consideration differing competence levels," says Datron CEO, Kobus le Roux. "It also has to be fair to those subjecting their vehicles and loads to scrutiny."

Roux says talks are underway for Datron to license WinNuwei from the CSIR for use in the Western Cape.

ENQUIRIES:

>> **Michael Roux**

mproux@csir.co.za

ROBOTICS FOR CLIMATE SCIENCE IN THE SOUTHERN OCEAN

Powered by wave energy, a robot glides slowly through the remote and turbulent waves of the Southern Ocean, measuring the flux of carbon dioxide between the atmosphere and the sea. The deployment and piloting of the robot, together with the sensors that it carries onboard, are major outputs of a partnership between the CSIR and a local engineering SMME.

“The Southern Ocean encircles Antarctica and plays a critical role in buffering the impact of climate change,” says oceanographer and CSIR chief researcher Dr Sandy Thomalla. She says it absorbs 50% of the globe’s ocean carbon dioxide uptake (both man-made and natural), yet it remains the least studied of all the world’s oceans because its waters are so hard to reach and rough to navigate.

Thomalla is the research group leader of the Southern Ocean Carbon-Climate Observatory (SOCCO), which is hosted at the

CSIR with support from the Department of Science, Technology and Innovation (DSTI).

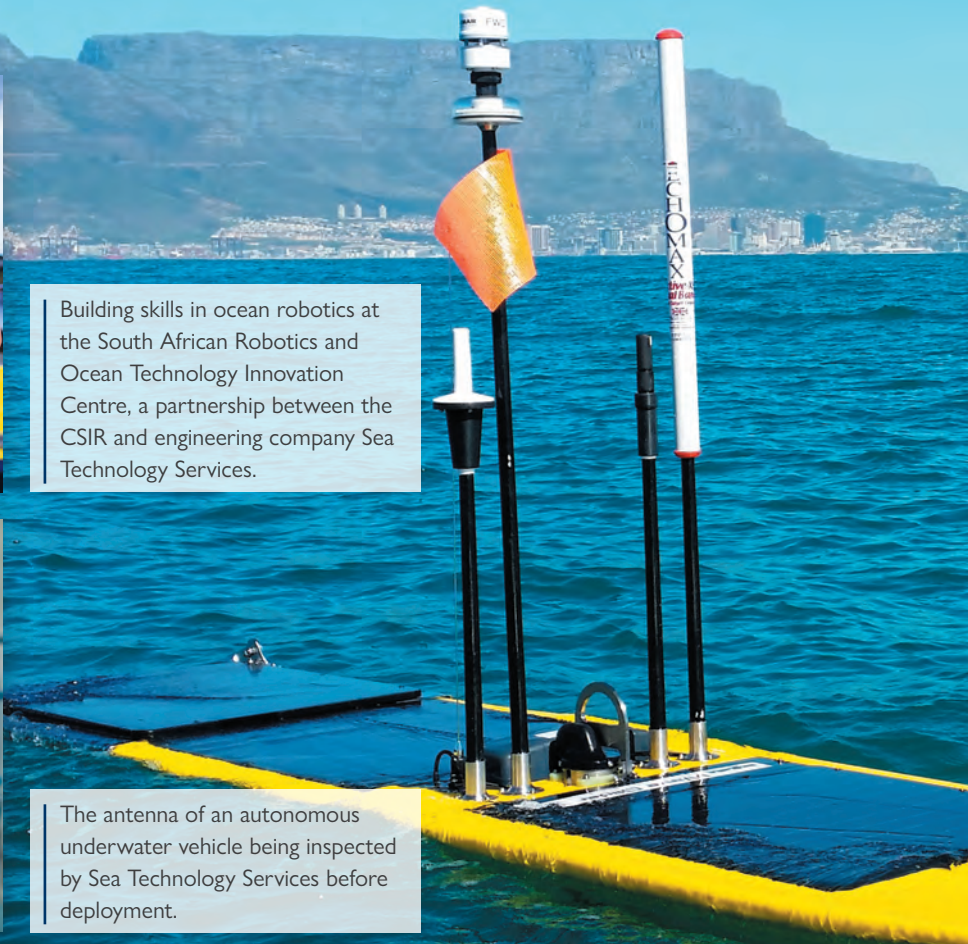
SOCCO incubated the South African Robotics and Ocean Technology Innovation Centre (SA-RobOTIC) 13 years ago as part of a partnership with local innovative start-up engineering company Sea Technology Services. SA-RobOTIC provides the support to enable efficient and effective use of both ship-based profiling and ocean gliders in support of South African carbon-climate science.



Building skills in ocean robotics at the South African Robotics and Ocean Technology Innovation Centre, a partnership between the CSIR and engineering company Sea Technology Services.



The antenna of an autonomous underwater vehicle being inspected by Sea Technology Services before deployment.



“An important spin-off from the investment in robotics technology is the sensor and platform innovation, guided by SOCCO’s research needs,” says Thomalla.

Because the Southern Ocean is so remote, scientists need very specific observing technologies that are capable of sampling thousands of km away and observing multi-cross-scale processes acting across the atmosphere and ocean. “SOCCO pioneered the use of ocean robotics in the Southern Ocean through multi-platform seasonal cycle experiments that advance our understanding of the physical and biological drivers of the seasonal cycle.”

“The Southern Ocean is also typically under-sampled in winter, so there is a bias in observations,” she says, adding that Wave Gliders typically rely on solar power to operate their sensors, which makes them challenging to operate under the low-light conditions of polar winters.

To close this observation gap, SA-RobOTIC developed a versatile, high-precision pCO₂ analyser (VeGAS-pCO₂), which is optimised for long-term CO₂ flux observations at lower cost and increased robustness to endure the harsh operating conditions typical of the Southern Ocean. In addition, SA-RobOTIC is developing an underwater hydro-generator to power the robot-mounted instruments during winter months.

These technologies now form part of the core of SOCCO and the broader South African ocean-climate science landscape. “It has stimulated funded international collaborations, and enables the science and skills needed to meet national goals,” says Thomalla.

Indeed, SA-RobOTIC also provides training and capacity building for technicians and engineers so that they can be absorbed into the economy.

Since 2011, some 33 electronic engineering technicians received training and mentorship towards their National Diploma in Electrical Engineering or Bachelor of Technology Engineering Degree. Some of these successful candidates have gone on to work at SA-RobOTIC.

“This partnership between the CSIR and small business Sea Technology Services has led to South Africa’s leadership in ocean robotics for marine science and a deeper understanding of critical processes that regulate global climate,” says Thomalla.

SEA TECHNOLOGY SERVICES

SA-RobOTIC is a 13-year partnership between the CSIR-hosted Southern Ocean Carbon-Climate Observatory (SOCCO) and an SMME called Sea Technology Services (STS).

“Our collaboration with a specialised SMME has contributed to a national ocean technology, innovation and operations centre with international recognition,” says Thomalla.

Through SA-RobOTIC, the CSIR and STS worked together to train 33 technicians and to develop ocean robotics technologies onboard a Wave Glider robot used to measure carbon-dioxide exchange between the atmosphere and the Southern Ocean.

According to their website, STS specialises in the design and manufacture of custom electronic systems, subsea and ship-based instrumentation products and solutions, as well as the import, supply and support of leading-brand oceanographic and marine instrumentation and sensors. STS is a 26% black woman-owned business with a level 1 broad-based black economic empowerment status.

ENQUIRIES:

>> **Dr Sandy Thomalla**
sthomalla@csir.co.za



Prof. Gerrit Basson of small enterprise ASP Technology with senior project managers from the Water Research Commission, from left, Lesego Gaegane, Thabo Mthombeni and Wandile Nomquphu atop a model of the planned infrastructure upgrade that will minimise flood damage from the Lourens River in the Western Cape. The model was constructed in the CSIR Coastal and Hydraulics Laboratory.

CAPE COAST FLOOD MITIGATION EFFORTS TO BE BUILT ON RIVER MODELS TESTED AT CSIR

The Lourens River in the Western Cape is prone to flooding, severely impacting communities in the coastal towns of Somerset West and Strand. The CSIR and engineering consultants at a small business called ASP Technology have just completed a modelling study that will assist the City of Cape Town to build a stormwater canal and floodplain walls to divert flood waters. This project demonstrates how the unique equipment and expertise available at the CSIR Coastal and Hydraulics Laboratory can support SMMEs.

Long before the concrete is poured for a new canal, dam or hydroelectric plant, engineers model, at a much smaller scale, the behaviour of the river, lake or port where the new structure will be built.

ASP Technology (Pty) Ltd., or ASP TECH for short, is an SMME that works with the CSIR to conduct hydrodynamic modelling studies that support large water infrastructure projects across Africa.

"Ours is the only facility of its size in the southern hemisphere, so we have the space and equipment ASP Technology needs for

its testing," says Eugène Mabille, who heads up the CSIR Coastal and Hydraulics Laboratory.

The 11 000 m² Stellenbosch modelling hall houses several precision instruments, including specialised basins where the flows and forces of water can be precisely simulated and measured in both 2D and 3D.

"ASP TECH has its own experts in river and dam hydraulics, but as far as the special basins for construction of the models are concerned, as well as other technical aspects within our laboratory, we support them," says Mabille.

These images show some of the modelling elements SMMEs and engineers use during hydrodynamic modelling studies that support large water infrastructure projects across Africa.



One of the most recent projects that ASP TECH and the CSIR collaborated on will help the City of Cape Town mitigate flooding of the Lourens River – an issue that once again gained prominence in 2023 when the river burst its banks, leading to catastrophic flooding and power outages in areas around Somerset West and Strand.

The design and investigation study for upgrading the river's infrastructure and flood alleviation measures was recently completed at the CSIR's laboratory, says Gerrit Basson, Managing Director of ASP TECH and Emeritus Professor in hydraulic engineering at Stellenbosch University.

As there are no comparable facilities in either the private or public sector that ASP TECH can contract for their modelling studies, this partnership demonstrates the critical role that the CSIR plays in supporting the growth of SMMEs through scientific expertise and infrastructure.

"Most of the projects that we work on have capital costs exceeding R500 million, and the hydraulic designs must be carried out with state-of-the-art hydrodynamic modelling and 3D physical modelling," explains Basson.

Mabille and Basson say their collaboration is important in the contexts of climate change and the average South African's need for safety and access to water.

"Our projects limit flood risk and ensure water supply during drought conditions while also addressing the water quality," says Basson. He says they design safe and sustainable dams, weirs, pump stations, hydropower plants and more, all of which require minimal maintenance.

The CSIR and ASP TECH completed a hydraulic model study in Mozambique, showing that they are also committed to addressing water management challenges beyond South Africa's borders.

Basson says they are currently working on another hydraulic engineering project, namely the Empuluzi diversion weir spillway design in Mpumalanga.

ASP TECHNOLOGY (PTY) LTD.

ASP TECH is an SMME based in South Africa that specialises in numerical and physical modelling of hydrodynamic processes in catchments, rivers, reservoirs, lakes, estuaries and conduits. According to its website, the design of hydraulic structures is a key element of the business, and typical projects include river, reservoir, estuary and lake hydrodynamics and sedimentation investigations, as well as hydraulic modelling and river engineering. The enterprise also designs hydraulic structures such as dam spillways and large pumpstations, conducts flood hydrology and stormwater studies, and models water quality in rivers, estuaries and lakes.

ENQUIRIES:

>> **Eugene Mabille**
emabille@csir.co.za

Paul Olivier, Technical Director of Key Bricks, explaining how the foundation was laid for the demonstration structure. It took only six days to get this house to above window height; built by six labourers with no prior building experience.



The CSIR partnered with USE-IT and Key Bricks (Pty) Ltd. in KwaZulu-Natal to develop a prototype block that uses recovered crushed glass as well as construction and demolition waste.



Use-It is one of the collaborators in a circular economy green block demonstration project.



Glass collected by community members is crushed in a hammer mill.



A prototype block machine with specialised moulds.



The new interlocking block.

NEW INTERLOCKING BUILDING BLOCKS FROM GLASS AND CONSTRUCTION WASTE

The CSIR has partnered with an SMME and a non-profit organisation to demonstrate a new type of interlocking block made from recovered glass and building rubble waste. The blocks are suitable for use in the housing and manufacturing sectors. The project is expected to provide informal employment opportunities, especially for women who reside in rural areas.

With grant funding from the Department of Science, Technology and Innovation, the CSIR (the project lead), USE-IT (a KwaZulu-Natal-based waste beneficiation, non-profit and SMME incubator) and Key Bricks (Pty) Ltd. (a block machine design and fabricator) have collaborated to showcase a new innovative and green block.

The new block offers several benefits, including the use of reduced virgin materials and natural resources such as river sand, stone and water. It is designed to interlock like LEGO® blocks, requiring minimal mortar and cement for bonding. This design allows for the built structures to be easily deconstructed and the blocks to be reused. Additionally, the blocks feature an internal opening for water pipes or electrical conduits, reducing the need to cut grooves (also known as 'chasing') or channels, ensuring that the blocks remain intact.

The block-making machine is being demonstrated to the private sector, municipal officials, housing-sector representatives and other SMMEs in the building and block-making sectors.

The mix ratios for the blocks and the design of the structures are informed by CSIR's research. The partners are seeking certification from Agrément South Africa, the regulator of non-standardised construction products and systems, to promote market uptake.

"The waste and recycling sector in South Africa holds enormous potential," says CSIR senior researcher and project manager Aubrey Muswema. "Our collaboration in this initiative will encourage sustainable building practices for SMMEs while addressing pressing societal needs such as low-income housing provision, boosting recycling offtake of glass and construction and demolition waste."

A demonstration top structure has been erected at the USE-IT Hammarsdale facility in KwaZulu-Natal.

SMMEs AND THE GREEN BLOCK PROJECT

- **Demonstrating blockmaking for SMMEs:** USE-IT hosts the demonstration equipment onsite to showcase the new technology to SMMEs.
- **Creating new SMME block makers:** It takes approximately six months to 'graduate' a single SMME, with between six to twelve full-time workers being trained in the use of the block-making machine.
- **Assisting existing SMME block makers transition to a green block:** The demonstration site provides an opportunity for existing SMMEs in construction and blockmaking to see the machine in operation.
- **Providing a source of income for waste pickers collecting construction and demolition waste:** The circular design embedded in the block-making machine means that up to 70% of virgin materials can be replaced with recovered construction and demolition glass waste, providing an income stream for SMMEs adept at recovering these input materials.
- **An opportunity for new skill development:** New skill opportunities have emerged from the project, including laying the house foundation course (a critical and specialised process) and laying the first two levels of blocks (these need to be laid plumb and true). These are additional revenue streams that the SMMEs can monetise, market and specialise in.

ENQUIRIES:

>> **Aubrey Muswema**
amuswema@csir.co.za

Small, medium and micro enterprises benefitted from a support programme for rural television white space operators. At a gathering at the CSIR are, from left, Njabulo Hadebe, CEO of AfricaLearn; Nkosinathi Mbele, CEO of AdNotes; Tshego Mpete from Broadband Infraco; Genesis Phasha, CEO of Eyelook; Songezo Mhambi, CEO of Mdantsane Mobile; Lwakhe Sangweni, CEO of Sleetime Solutions; and Thabo Mokgotho, CEO of Kasi WiFi Connect.



SMMEs ROLL OUT TECH THAT USES IDLE RADIO FREQUENCY SPECTRUM FOR BROADBAND

Thirteen rural and township communities across six South African provinces have so far benefitted from affordable wireless broadband services, thanks to the deployment of CSIR technology that utilises idle radio frequency spectrum. This was made possible by the empowerment of 11 SMME wireless internet service providers, who were key in rolling out the CSIR-developed technology.

Television white spaces (TVWS) are the unused spectrum channels in the TV broadcasting frequencies. The CSIR developed a tool that dynamically identifies and makes available these idle radio frequency spectrum resources, which are primarily allocated for broadcast television services, to provide affordable broadband services. Such services can be offered by wireless network operators without causing interference with the primary licensed services. This harmonious co-existence between TVWS-based wireless broadband networks and TV

broadcasting networks is made possible through CSIR-developed technology that serves as a dynamic spectrum switch.

Since 2020, the CSIR and the United Nations Development Programme have supported youth and women-owned SMMEs to bridge the digital divide in rural and township communities using the CSIR spectrum switch. Other collaborating partners supporting the Rural TVWS Operator Support Programme include the British government through the

Foreign Commonwealth Development Office and SEACOM, a commercial network company with extensive information and communications technology and data infrastructure in South Africa.

The programme enhances access to affordable broadband internet connectivity through public hotspots, provides broadband internet connectivity to public facilities, improves digital literacy and creates job opportunities for the 11 SMMEs that serve as rural operators.

By April 2024, beneficiary SMMEs in both phases have collectively created 114 job opportunities. Some 70 026 users were connected to the network through 212 public facilities, 2 637 households, 273 local small businesses and 183 public hotspots.

The ongoing expansion of the TVWS network continues to improve the lives of South Africans.

ABOUT THE SMMEs

Beneficiary SMMEs supported under this programme are located across six provinces, namely, KwaZulu-Natal, the Eastern Cape, Limpopo, the Free State, Mpumalanga and the Western Cape. Six of these SMMEs are youth-owned, namely AdNotes, Pazima IT, Eyelook Telecom, To Data Technologies, KasiWiFi Connect and Mdantsane Mobile. Additionally, five are owned by women: AfricaLearn, Kathabo Technologies, Sleep-Time Solutions, Mfene Telecoms and Black Equations.

Details are included below of some of the beneficiary SMME network operators that were granted the TVWS-based wireless broadband network infrastructure, connecting public facilities, households, small businesses and public hotspots.

Kathabo Technologies provides affordable broadband connectivity services to the Botshabelo township community located in Mangaung, Free State Province. Botshabelo is a rural township considered one of the largest in the country, situated about 45 kilometres from Bloemfontein. With an estimated population of 187 000, Botshabelo has benefited significantly from Kathabo Technologies' efforts during this programme support period.

AdNotes, headquartered in Port Shepstone in the Ugu District Municipality of KwaZulu-Natal, was founded in 2011. AdNotes has significantly advanced the provision of affordable broadband services to rural communities, particularly in iXopo in the Harry Gwala District Municipality.

Eyelook Telecom was founded in 2013 and operates from the Jane Furse community in the Sekhukhune District Municipality

in Limpopo. The Jane Furse community is situated within the Bapedi tribal area.

KasiWiFi operates from Kroonstad, located in the Moqhaka Local Municipality, Free State Province. Founded in 2019, KasiWiFi has achieved remarkable success in providing affordable broadband services to communities in Moqhaka during the programme support period.

Sleep-Time Solutions is headquartered in KwaMhlanga, located in the Nkangala District Municipality, Mpumalanga Province. Sleep-Time provides broadband wireless services to the communities of eMpumelweni, Sheldon and other surrounding areas in KwaMhlanga.

AfricaLearn is headquartered in Durban, Ethekewini Metro, KwaZulu-Natal. Founded in 2013, AfricaLearn has achieved significant milestones in providing affordable broadband services to rural communities in the Ndwedwe, Ilembe District Municipality.

Mdantsane Mobile operates from Mdantsane, the second largest township in the country, located 15 kilometres from East London in the Eastern Cape Province. Mdanstane is considered a poor community with an approximate population of 157 000. Mdantsane Mobile was founded and owned by Songezo Mhambi.

To Data Technologies operates from Mthatha in the King Sabata Dalindyebo Local Municipality, OR Tambo District Municipality, Eastern Cape. Founded in 2014, To Data Technologies has achieved significant milestones in providing affordable broadband services to township communities around Mthatha.

Pazima IT operates from Emondlo in the Abaqulusi Local Municipality, Zululand, in KwaZulu-Natal. Founded in 2019 in Vryheid, Pazima IT takes pride in serving local businesses, schools and government facilities in the Emondlo community. They help these entities thrive in their day-to-day operations by providing affordable, reliable and fast wireless internet services.

Mfene Telecoms operates from Gqeberha in the Nelson Mandela Bay Metro in the Eastern Cape. Founded in 2020, Mfene has excelled in providing affordable broadband services to township communities around Nelson Mandela Bay.

ENQUIRIES:

>> **Luzango Mfupe**
lmfupe@csir.co.za

ScienceScope

www.csir.co.za