

ScienceScope

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SCIENCE
FOR SOCIETY

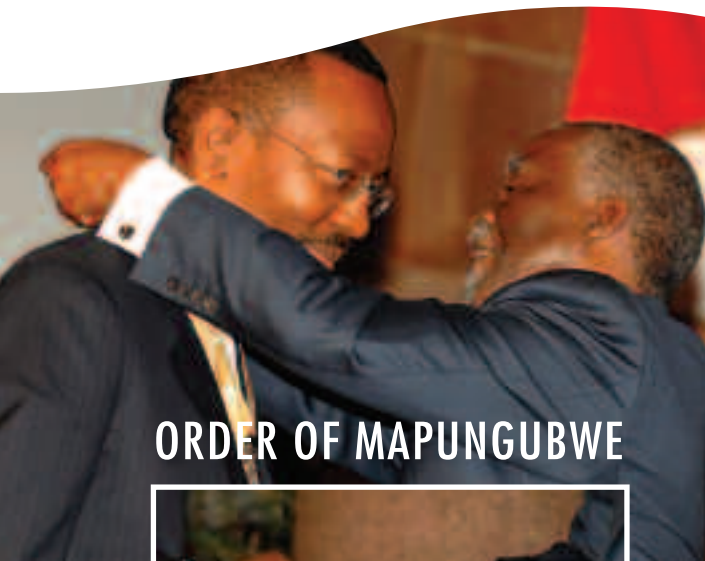
CSIR

our future through science

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Science for Society

Many of the articles in this edition of *ScienceScope* recognise the pivotal role of the Department of Science and Technology in activities to empower society through science.



President Thabo Mbeki bestowed the Order of Mapungubwe: Silver on Dr Sibusiso Sibisi, CSIR President and CEO, in September this year, for his contribution in the field of information technology in South Africa

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The impact of science on society

Science and technology (S&T) is integral to addressing priority issues including poverty and unemployment; health (especially infectious diseases); alternative sources of energy; service delivery (e.g. infrastructure) and sustainable development.

The central role played by technology in economic development is increasingly acknowledged internationally, and there is no doubt that scientific knowledge and innovation could jump-start and sustain our continent's development process and ensure that we meet the Millennium Development Goals." These were the words of the President of South Africa, Mr Thabo Mbeki, at the inauguration of the Cape Town component of the International Centre for Genetic Engineering and Biotechnology in September this year.

Similarly, the Human Development Report of the United Nations Development Programme (UNDP) states, "Technology is like education – it enables people to lift themselves out of poverty."

The public sector (including government, science councils and academia) and the private sector must join efforts to serve the public good. And as a public research institution, the CSIR has a mandate to contribute towards the socio-economic advancement of the people of South Africa.

It can be argued that there is not yet a widespread appreciation of the many faces and roles of science and that society has not come to fully understand the value that S&T advances can bring to their daily lives. This edition of *ScienceScope* focuses specifically on the direct impact that S&T can have on improving the quality of life of people.

Introductory remarks consider the diffusion of technologies within societies, and social acceptance of some technologies. Projects featured showcase the spectrum of CSIR research and development – from knowledge generation and implementation to impact.

Beneficiaries of projects include rural, peri-urban and urban communities; the youth; people with disabilities; and women. Impact areas selected span health; education; safety and security; socio-economic impact; and services.

The CSIR should partner with society, as a key beneficiary of S&T, in finding solutions for new challenges that we shall be facing along the road. As a research organisation with its roots in Africa, we know the context of our continent, its people and their needs. It is paramount that we remain focused on the relevance of our research and its implementation through results that make a marked difference. That will be science in service of society, science for society.



CSIR President and CEO

"Technology is like education – it enables people to lift themselves out of poverty."

Relevant science does not automatically signify social acceptance

by Khungeka Njobe, CSIR Group Executive:
R&D Outcomes and Strategic Human Capital Development

Technology transfer is one of the strategies our organisation pursues to achieve our mandate. We define it as the process of developing practical applications from the results of scientific research and ensuring that these are adopted by society.

Themes such as the 'global village' and 'technology age' are almost clichéd if one looks at our society's reliance on all things technical. What was once viewed with great trepidation, such as the motor car, we can now hardly live without. Not to mention everything else we develop and use to make our lives easier and 'faster'. Government's belief that science and technology are crucial contributors to the advancement of South Africans stands firm enough to influence the GDP. Added to this, millions of rand are spent on research and development (R&D) by stakeholders, and calls for even greater investment in R&D and human capital development in the science sector have been made globally.

With the international community, and South Africa, so steadfastly continuing on the science, engineering and technology course, how is it that the rate of technology *acceptance* does not correspond with the rate of technology *development*? What are the factors that influence a community's acceptance of certain technologies regardless of an established need for the technology?

One case in point is the AmaDrum project, an initiative of the CSIR, the Department of Health, the Eastern Cape Development Corporation and Technology for Women in Business during the early 2000s. The need was clear and immediate: To curb the problem of a lack of clean drinking water as this results in cholera outbreaks and other water-related diseases.

The science behind the proposed solution was tried, tested and found to be successful. The intended beneficiaries were many and included the various affected communities as well as the small, women-owned enterprise contracted to manufacture and distribute the AmaDrum in the Eastern Cape – ostensibly a win-win situation.

One of the findings of a preliminary report showed that the communities viewed the drums as an interim solution during the cholera outbreak and not as a product for permanent use. In this area where water was already scarce, the recipients also preferred tap (running) water, not drums and thus this solution was rejected by some. Although further lessons can be learned ranging from issues of management, marketing and training, community acceptance is key.

A positive example is that of the FabLab. The CSIR's Technology Transfer for Social Impact office was contracted by the Advanced Manufacturing Technology Strategy to package and transfer the FabLab technologies to a facility in Soshanguve, a township north of Pretoria. The FabLab gives local users the ability to conceptualise, design, develop, fabricate and test different types of products from different materials, opening numerous possibilities for innovative solutions to common problems and needs, particularly in areas that have 'technological gaps'.

The transfer was completed and counts as one of the initiative's successes. Could a part of the success be attributed to the specific transfer process that was followed?

This included:

- Stakeholder and community mobilisation and alignment
- Assessing the infrastructure in terms of readiness to absorb the technology
- Awareness creation and preparing the infrastructure for transfer
- Transferring the technology package and providing the necessary training
- Providing aftercare support
- Monitoring and evaluation to ensure social acceptance of the technology and to identify any facility changes that might have to be made.

In a paper by the Meraka Institute and MetaLAB (Sussex University), titled *From Technologists to Social Enterprise Developers: Our Journey as 'ICT for Development' Practitioners in Southern Africa*, the authors advocate a changed mindset where researchers and developers move from "researching, developing and deploying technology tools" to "establishing an ICT-enabled, sustainable community of enterprises".

It seems that a more 'collaborative' process is suggested where the intended beneficiaries are not simply the recipients of technological solutions, but also partners in as far as their views and buy-in are sought ahead of time and during the development process.

The paper further states that the study has confirmed the importance of a 'local champion' – some trusted community member with a good track record and entrepreneurial interest who acts as the community's access point. These champions would typically act as bridge builders between the community and technology development or implementation.

The authors categorise their learning about the adoption phases for technology in a rural context as *innocence* (unchallenged, undisturbed and traditional), *bewilderment* (exposure to a new technology where the initial reaction could be to stall or avoid it), *amazement* (once skilling has taken place and the usability has been established), and *mastery* (where the long-term benefits are appreciated).

However, it is still not certain whether knowing and using the way people traditionally accept new ideas, products or services would have assisted in the AmaDrum case where the community was expecting something else.

Although we are not acceptance theorists, it is to our advantage to

understand how our technology could best be transferred and accepted. Literature on community or social acceptance is broad, specifically in the ICT arena, and goes as far back as the 1980s. (See Dillon and Morris, 1996, for a review of theories and models.)

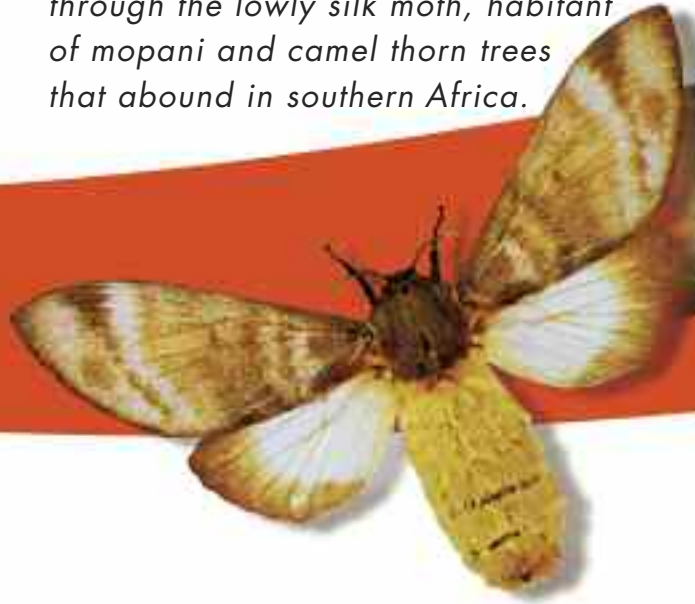
Three of the five characteristics put forward by Rogers (1995) seem to find resonance with other theorists, i.e. relative advantage, compatibility (with social practices and norms) and lack of complexity. Shackel (1991) hones in on utility, usability and cost. Alavi and Joachimsthaler (1992) suggest the most relevant factors to be cognitive style (of processing and using information), personality (taking risks or issues of control), demographics and user-situational variables. Davis *et al* (1989) in the technology acceptance model also cite perceived usefulness and ease of use as the major factors towards acceptance.

There is still no definitive answer, except for the fact that social or community acceptance of a particular technology, 'obviously' designed to improve lives, is not a given. At the CSIR, we have to cast our planning nets wider to include intelligence about the intended recipients to help guide the development and implementation process and ensure user acceptance.

At the CSIR, we have to cast our planning nets wider to include intelligence about the intended recipients to help guide the development and implementation process and ensure user acceptance.



Our future through science – paying homage to its mandate and this promise, the CSIR embarked on a research project recently that benefits disadvantaged communities through the lowly silk moth, habitant of mopani and camel thorn trees that abound in southern Africa.



Yarn being spun from the wild silk strands

Cocoons before degumming

Indigenous moth could ensure a future through science

IT IS FROM THE dusty cocoon of the African wild silk moth and after having once gone through a process of metamorphosis, from caterpillar to moth, that another magical process takes place – extracting luxurious silken strands from the discarded cocoon to find their way to *haute couture*.

The moth (*Gonometa postica*) is of particular economic interest as the silk fibres obtained from the cocoons of *G. postica* are of exceptional quality comparable to that of the domesticated silk moth, *Bombyx mori*. This holds promise as a potential income-generating resource for the indigenous people of southern Africa, while not harming or endangering the environment.

At the CSIR offices in Port Elizabeth, natural fibres such as wild silk are being used to create exciting new fabrics with excellent properties while being sustainable.

Cocoons from the African wild silk moth are attached to camel thorn and mopani trees throughout the North West, the Northern Cape and Limpopo provinces of South Africa, as well as in Namibia, Botswana and Zimbabwe.

From this unique fibre, yarns are spun – some by machine, others by hand. Used as pure African wild silk or blended with other natural fibres, the yarns are woven into unique creations.

The silk fibres of short lengths, the by-product of long silk fibre staple spinning processing, is blended with cotton and can be spun and woven in a similar way to that used for the spinning of cotton. The fabric derived from long silk fibres processed on the long-staple spinning process has a rich natural honey colour and is woven to produce a soft, durable fabric with a luxurious feel. African wild silk is versatile and elegant – with a hint of its untamed origins in the camel thorn and mopani forests of Africa.

In a pilot project located at Ganyesa and Morokweng in the North West, these cocoons are collected, cleaned and degummed.

As the moth has already emerged from the cocoon, the natural cycle is not disturbed, thereby ensuring sustainability of the resource.

Current activities at Ganyesa include degumming (through a process developed by the CSIR), hand spinning, hand weaving, sewing and dyeing. In addition, the North West small, medium and macro craft enterprises are utilising fabrics from cotton and silk, which expand the potential and through which more job opportunities are created. Particular fabrics are produced from the wild silk harvested.

Processing at the CSIR involves a chain of modern processing equipment to convert degummed cocoons into fabrics. The process requires the silk fibre to pass through some 22 specialised processes to convert the cocoons into finished fabric.

The southern African region is rich in natural resources of textile-based fibres, notably wool, mohair, cotton, sisal, wild silk and unexplored or under-explored fibres that could be derived from indigenous plants and

animals. These include untapped sources of commercial fruit crops, such as banana and pineapple. The potential exists for complete beneficiation of these natural fibres within the region to produce export marketable, high-value, niche products, thereby creating employment and income-generating opportunities.

For the region to fully realise the commercial benefits of these natural fibre resources in a sustainable and economically-viable manner, a holistic approach needs to be adopted for value-addition processes of these fibres. This includes the identification of the overarching need for export market research, research and development, training, technology upgrading, skills development, product development and innovation, assistance with technology improvement, and relevant education and training support.

The CSIR has embarked on an investigation with the United Nations Industrial Organization (UNIDO) to ascertain the feasibility and facilitate the development of a wild silk industry in southern Africa. Collaboration amongst regional

stakeholders is critical in the development of an economically viable and sustainable wild silk industry as this is wholly dependent on volumes of collected empty shell cocoons. This would also ensure a coherent approach to addressing poverty in the region while developing national S&T to promote sustainable socio-economic development.

The establishment of a sustainable wild silk industry in Africa could pave the way for similar Africa-unique projects to capture the true spirit of the continent. That spirit that determines her worth and echoes in her truths: "Every morning in Africa, a gazelle wakes up. It knows it must run faster than the fastest lion or it will be killed. Every morning a lion wakes up. It knows it must outrun the slowest gazelle or it will starve to death. It doesn't matter whether you are a lion or a gazelle ... when the sun comes up, you'd better be running." (author unknown)

– Patsy Scholtz

Enquiries:

Sunshine Blouw

email sblouw@csir.co.za



The establishment of a sustainable wild silk industry in Africa could pave the way for similar Africa-unique projects to capture the true spirit of the continent.



When harvested and dried, Glycyrrhiza glabra, which is native to south-east Europe and south-west Asia, is a sought-after flavouring product in the confectionary, pharmaceutical and tobacco industries

A tale of four men, an alien plant and a liquorice factory

DESPERATION DROVE THE impoverished community of Dysselsdorp – a dusty hamlet about 25 km east of Oudtshoorn in the Little Karoo – to willingly surrender their precious natural resource for a pittance to an external market. The ingenuity and intervention of two foreign men helped them develop it into a gem beyond their belief.

Jan Gelant, Cedric Claassen, Nico Titus and Johnny Miggels are employees of the Dysselsdorp Liquorice Extract Factory. In a town with some 20 000 inhabitants and an unemployment rate estimated to be in excess of 50%, they consider themselves fortunate to be employed, even if it is just as general workers.

Gelant was born in Dysselsdorp 39 years ago. His education ended when he passed standard five (now grade seven) and he

subsequently spent his life working as a builder. When building jobs became scarce in 2001, he was forced to return to his arid Karoo hometown until he was approached by a friend in 2002. "Edmund September (a former factory manager) struggled to find work and at that stage I had been unemployed for more than a year," Gelant explains. "Edmund said three men from the CSIR arrived here and said that they had developed a way of extracting liquorice from a certain plant. Edmund and I helped to get this factory off the ground."

Louis Ackermann, Robin Learmonth and Charles Wyeth, now former CSIR employees, approached the community with their concept during the 1990s. The CSIR offered to supply technology to aid the community in extracting liquorice concentrate from the roots of the

naturalised liquorice plant (*Glycyrrhiza glabra*), an alien shrub growing along the banks of the Oliphants River. The shrub, said to be introduced by colonists more than 150 years ago, was used in the tobacco industry of the Little Karoo.

A factory established in 2001 became the sole supplier of liquorice extract in Africa. Financial support was provided by the Western Cape Department of Economic Affairs, the Klein Karoo Co-op and Kolping, a Roman Catholic non-governmental organisation. While the factory employs only seven permanent staff, more than 200 community members receive an income when they are hired during the harvesting period from May to August. They are paid per kilogram of wet roots supplied, which are dried for two weeks and put through a hammer mill.



Employees can monitor the density of the resultant liquorice product in an analytical laboratory sponsored by British American Tobacco

The factory is equipped with a customised counter-current extractor that complies with European Union standards. The extracting can be compared to obtaining flavour from a tea bag. The extract is pumped into settling tanks and the water and extract are then separated into evaporation tanks. The extract is processed into powder blocks or liquid, depending on the buyers, and packed for distribution. According to the current general manager Emile le Roux, a Dysselsdorp local who started there as a general worker, the factory produces about 25 000 - 30 000 tons of liquorice per year.

"Our community knew these roots were valuable and used to sell it in Oudtshoorn from where it was exported elsewhere. The community's only downfall was that we did not have the technology to extract the liquorice ourselves," says Gelant.

For him the establishment of the factory meant not only a steady income, but also more time with his family. "When I was a builder I was constantly away from home and returned only fortnightly. Now, I sleep in my own bed every night," smiles Gelant, who supports his unemployed wife and their three children aged 17, 13 and 11.

Titus (27), Miggels (35) and Claassen (26) joined the factory after completing electrical engineering diplomas – a course offered at Kolping – but not before experiencing the frustration of unemployment.

"I could not study further due to financial constraints," says Claassen. "The unemployment numbers here are very high – I know because I was one of them. When I got this job at the factory, I decided to work my way up from general worker to shift manager," he says proudly. "This enabled me to support myself, my parents, grandparents and my unemployed sister who has a baby."

Miggels joined the factory four years ago. This is his first permanent employment after surviving on piece jobs for most of his life. "If I hadn't been employed here, I don't know how our family would have survived only on the pensions of my maternal grandparents."

Titus pipes in: "Just the fact that you can go into a furniture store or any other place and say that you have a full-time job means you're credit worthy – that feeling is priceless." The factory has also become a tourist attraction and thus further contributes to the local economy. Tourists visiting the factory situated just outside the town are often

lured further in and end up sleeping over at the Kolping guest house. The factory has expanded its operations to include essential oil cultivation and extraction. Currently the pungent smell of geranium competes with the dry acrid Karoo dust in the factory backyard.

"This is really a success story," says the CSIR's Helena Heystek, who is also a member of the Dysselsdorp Liquorice Company board. "They run according to their own structure and finances; they take ownership and are very proud of the business."

Katrina Lewie, the local librarian and a member of the steering committee established during the initial stages of the project, is glad that the community now receives money during the harvesting period. "I hope the factory is here to stay, that it develops into something bigger and provides even more job opportunities."

– Asha Speckman

Enquiries:

Helena Heystek

email hheystek@csir.co.za

Permanent employees at the liquorice factory (back): Nico Titus and Johnny Miggels; (front) Jan Gelant, Brian Koopman, Cedric Claassen and Hendrik Jantjes



Indigenous foods meet technology

Dipabi, marula, umnqusho and mopani worms are South African indigenous delicacies that have been revived through CSIR technology and will soon be sharing a platform with western foodstuffs.

THE TSASETSO FOODS Co-operative is a subsidiary of IndiZa Foods (a Section 21 company formed with the CSIR's assistance), and is based in Bloemfontein. This is another poverty alleviation and job creation venture arising from the CSIR's promotion and commercialisation of indigenous foods, made possible through funding from the Department of Science and Technology.

"We focus on the production of indigenous foods, product development and training of the community," explains Lesego Sejosengoe, manager of the organisation. The idea of coupling modern technology with indigenous knowledge to improve traditional culinary products and elevate them to a marketable standard, birthed similar businesses such as Isintu Foods, established in Richards Bay and Chivirikani Foods in Limpopo.

"It was interesting for people to see how technology can complement their traditional methods of preparing indigenous foods and how, through this advancement, the shelf life of products can be prolonged," she says.

The commercialisation of these food dishes is keeping the local heritage alive.

According to Morewane Mampuru of the CSIR, the organisation has also developed technology to manufacture crisps from amadumbe. Amadumbe is a potato-like indigenous tuber that resembles a sweet potato and is grown in KwaZulu-Natal as a subsistence crop. The amadumbe is nutritious, drought-resistant and easy to grow. Various other products are processed from mopani worms and marula fruit. The products are sold by the communities who manufacture the goods; plans are afoot to ensure that these tasty delights appear in retail stores in the near future.

Enquiries:

Morewane Mampuru
email mmampuru@csir.co.za

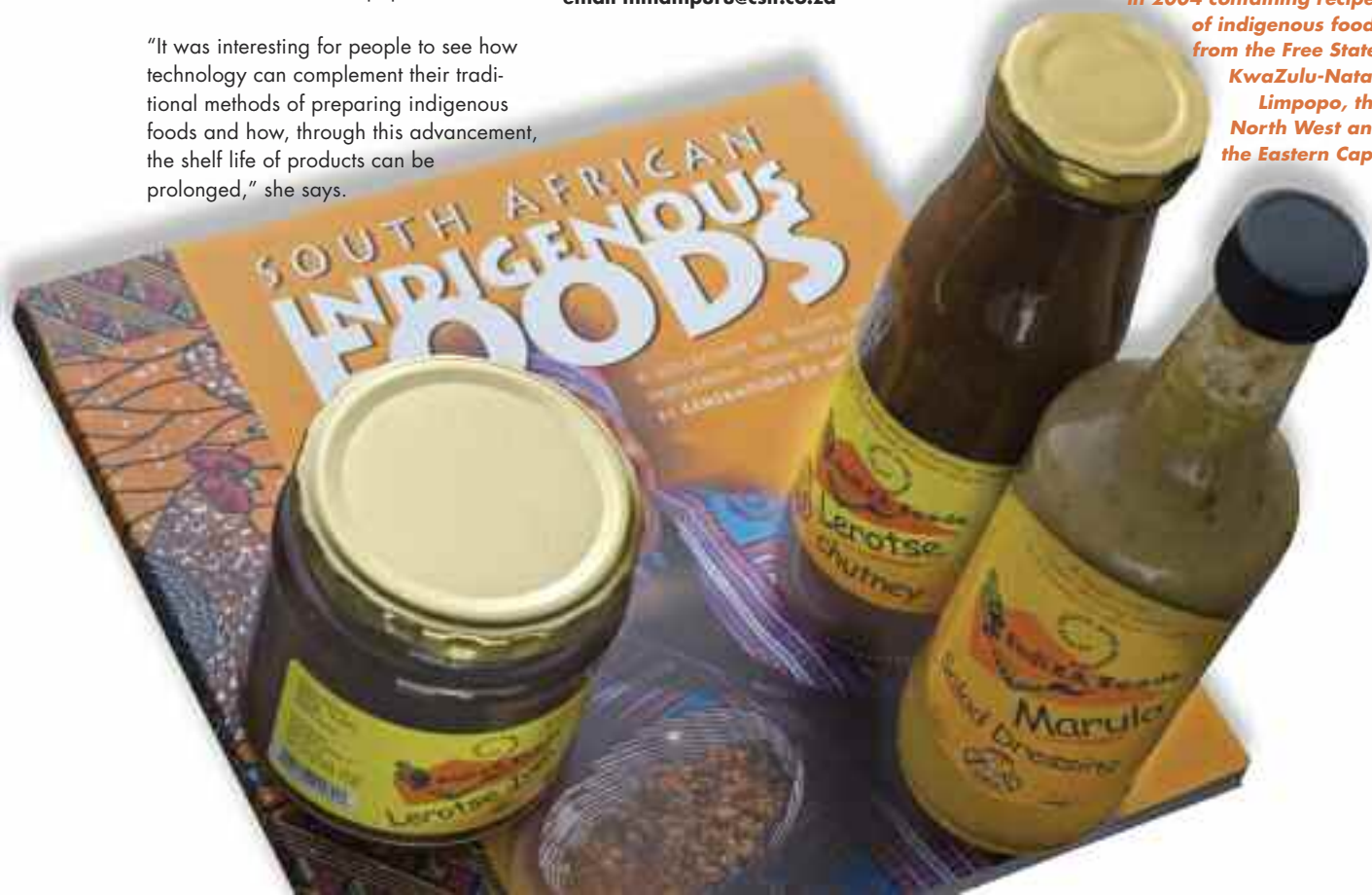


The humble mopani worm ... The CSIR has transferred processing technologies to enhance its value as a snack, stew and other products



Amadumbe, the African sweet potato that is grown in abundance in KwaZulu-Natal, is said to be nutritious and drought-resistant

The CSIR published a book in 2004 containing recipes of indigenous foods from the Free State, KwaZulu-Natal, Limpopo, the North West and the Eastern Cape



A community enterprise blooms in the dry Northern Cape

ANDRIES MOSIMENG KNOWS the Northern Cape. And he knows the area around Onseepkans – a small town on the banks of the Orange River in a remote stretch of rocky, dry land – like the palm of his chapped hands. He knows what the weather has in store; how the soil swallows the water, draining it almost instantaneously; and importantly, he knows and understands the people of Onseepkans.

Having worked on grape farms in the area for 15 years, what Mosimeng did not know, was that one day he would be heading up a project for the large-scale cultivation and distillation of rose geranium – a crop he has never heard of – right here in Onseepkans. But by 8 August this year, when a sophisticated new distillation plant for rose geranium essential oils was formally launched by Science and Technology Minister, Mr Mosibudi Mangena,

there was not much that Mosimeng did not know about growing, harvesting and distilling rose geranium.

The project came about through dedicated efforts and funding by the Department of Science and Technology (DST) for the establishment of community-owned businesses through technology transfer.





Andries Mosimeng

“ I am excited and fulfilled – this is the job for me. And the Sidasoas workers are delighted to generate an income and to be part of a project as ambitious as this one,” says Mosimeng.

The department had included essential oils as a focus of agroprocessing community businesses that could reduce poverty across the country.

Essential oils are volatile constituents of aromatic plants that are typically extracted from leaves and flowers through steam distillation. The fragrance of the different essential oils typically determines the use, be it in perfumes, cosmetics, household fragrances or as food and beverage flavourants. Trade in essential oils and related products is reportedly growing by 10% annually.

The CSIR was uniquely placed to transfer technologies required for communities to establish essential oils businesses at identified sites across the country, as its biosciences researchers had in the past undertaken research on oil yield and chemical analysis of essential oils.

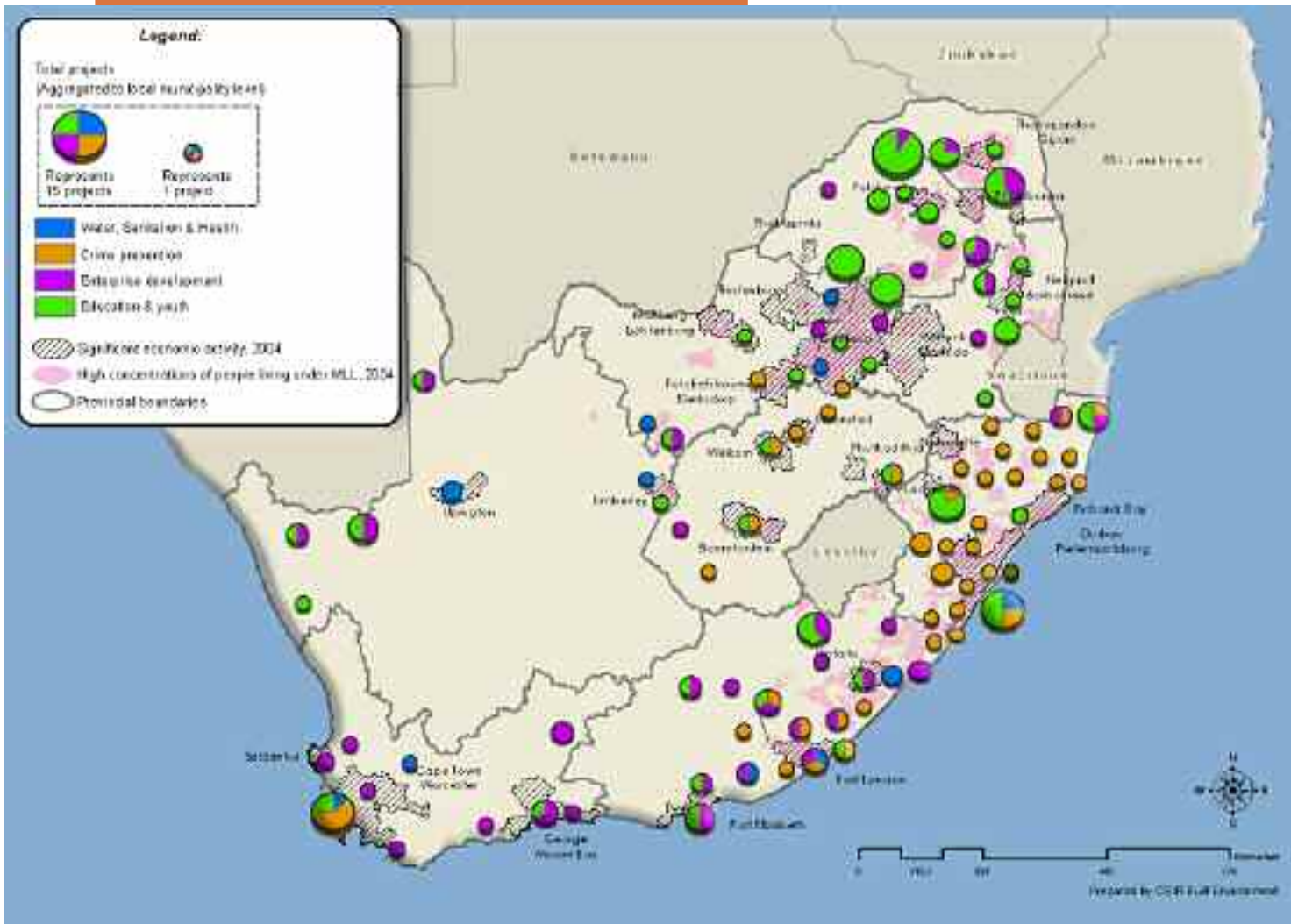
At Onseepkans, rose geranium was selected for cultivation as it is well-suited to the fast-draining soil, abundant sunlight and irrigation water on tap from the Orange River. A hybrid species, derived from the *Pelargonium* species indigenous to South Africa, is cultivated and it has an earthy-sweet, smooth and dry aroma with varying citrus undertones.

“Although I have not heard about rose geranium before, I have always been good at cultivating plants, so the learning curve was not that steep,” says Mosimeng.

“As far as the technicalities of distillation are concerned, a young man by the name of Marthinus Jonas is turning out to be quite a technocrat. If someone experiences a problem on the distillation plant, Marthinus is the man most likely to solve it. Perhaps it has something to do with the youth’s ability to master technology matters so much faster than older generations,” Mosimeng smiles.

The facility is designed to process plant material at a maximum rate of eight distillations per day shift, at up to two tons of material per distillation. The facility comprises a boiler or steam generator, two mobile distillation vessels, a heat exchanger, an oil separator, an industrial cooling tower, a water treatment plant and a variety of laboratory equipment. It is planned that various hardware and software components will be installed in the near future to enable the gathering of data to monitor the environmental conditions and the process parameters of distillation facilities at remote locations. This includes data on temperature, humidity, wind speed and light intensity.

Engeli Beukman, CSIR project manager for Onseepkans, says it has been phenomenal to be part of so much progress. In the project’s three year history, an irrigation dam and pump house were built; an irrigation system installed; the distillation plant built and commissioned; and offices and ablution facilities constructed.



CSIR projects with direct social impacts



Rose geranium

To date, 30 hectares of rose geranium have been planted and workers have been trained in all aspects of running an agribusiness, from land preparation, fertilisation and harvesting to technical procedures on steam distillation, administration and financial control.

Beukman comments that Onseepkans is an impoverished community with high unemployment rates. Nearby grape farms offer mostly seasonal jobs. The rose geranium project has created 32 full-time positions to date.

"A similar project at Pella, also within the Khâi-Ma municipality area, has created jobs for 30 more people. This means that at least 60 individuals in a municipality with a high unemployment rate have benefited from this initiative," says Beukman.

Mosimeng was appointed as manager in December 2006 and a section 21 company, Sidasoas, has been established as the legal entity through which the community runs its business.

"I am excited and fulfilled – this is the job for me," says Mosimeng. "And the Sidasoas workers are delighted to generate an income and to be part of a project as ambitious as this one," he says.

How does steam distillation work?

Steam distillation allows the isolation of essential oils from any component of a plant, but typically from the leaves and flowers.

ESSENTIAL OIL IS extracted from plant material by steam, generated by a boiler, through a distillation vessel filled with the plant material. The heat of the steam breaks the membranes of the essential oil-containing cells in the plant tissue, releasing the oil into the stream of steam in the distillation vessel. The mixing of oil and steam facilitates the lowering of the boiling point of the essential oil components and the oil is carried in the vapour phase into a condenser where the oil and steam are cooled to their liquid phases. The condenser empties into an oil separator (Florentine flask), which allows recovery of the oil.

The distillation of essential oils requires expensive equipment, stainless steel vessels and correct designs. As it is possible to embed the correct processing conditions in the design and operation of the equipment, suitably trained workers can produce oil of consistent quality by implementing standard operating procedures rigorously.

Medicinal plants for natural remedies

THE DEPARTMENT OF Science and Technology (DST) invests in the medicinal plant sector as a key component of its strategy to create sustainable community businesses. Medicinal plant products include processed plant materials with application in a host of functional food, herbal supplements, pharmaceuticals, nutraceuticals, traditional medicine and related self-medication products.

Internationally, a large number of self-medication products are based on medicinal plants. DST-funded projects managed by the CSIR include the cultivation and processing of wild ginger for the treatment of allergies and asthma; *Hoodia gordonii* for obesity; devil's claw for inflammation; *Sutherlandia* as an immune stimulant; *Pelargonium sidoides* for treatment of colds and flu and milk thistle for treatment of stomach ailments.

Boyse Pillay, manager of the CSIR's technology transfer for social impact activities, says medicinal plant products may be based on well-established, exotic crops such as St John's wort, *Echinacea* and liquorice, or indigenous plants such as *Aloe ferox* and devil's claw. The markets for these crops are big and well established as the products have been traded for many decades.

– Alida Britz



Minister of Science and Technology, Mr Mosibudi Mangena, is introduced to essential oil extraction



Marthinus Jonas



(From left) Nomande Qongqo, Noluthando Mbilase, Nambulelo Tola and Thandiswa Myeki enjoy the fruit of their labour

“We were trained by CSIR experts and now we can do cloning, budding and grafting.”

Ditching aprons for gumboots to clone and propagate trees

THEFT, INCLEMENT WEATHER, forces of nature and even ridicule.

Noluthando Mbilase (43) and Nomonde Qongqo (42), fledgling businesswomen in Alice in the Eastern Cape, have seen it all and live to tell their tale of success.

The impoverished town of Alice is known as an educational centre that has produced many African leaders, including the President of South Africa, Mr Thabo Mbeki, and former President, Mr Nelson Mandela, who both have their roots in this town.

Alice is situated east of Fort Beaufort on the Tyume River and is also home to the Siyatyala Nursery project – an isiXhosa name that means ‘we are planting’. The nursery, the first of its kind in the Eastern Cape, is headed up its owners, Mbilase and Qongqo.

Five years ago the CSIR donated 900 *Eucalyptus* seedlings to a group of women in Alice. These seedlings were generated through extensive genetic research focused on improving the growth and wood qualities of commercial forest plantation trees, as well as genetic improvements of indigenous species with forestry potential.

Breeding, growing and cloning trees were foreign terms to these women. “To be honest, all we knew about trees was to chop them down for wood to make fire and cook for our families,” says Mbilase.

The CSIR supplied the women with *Eucalyptus* clones and pine seed material as well as material for cloning indigenous species such as yellowwood and *Acacia karoo*. The organisation also executed a comprehensive technology transfer exer-

cise and developed a training course, which included technical and business skills training. The two women were flown to Gauteng where they visited a number of successful commercial tree nurseries.

“We realised from the start that these two individuals had the potential to make a success of their business,” says Dr Steve Verry, leader of the CSIR tree improvement research group. “They had no difficulty with the pioneering application of cloning technology to the two indigenous species. Yellowwood propagation by seed is quite challenging, as the seed lives only for a short period of time. Vegetative propagation of yellowwood is a good answer to the problem, although the approach is relatively unexploited in this indigenous species; the two women nevertheless did it successfully.”



"Initially we couldn't find the pine bark (a medium used for propagation), not because it was rare," adds Mbilase, who co-founded the nursery, "but because we simply did not know where to look for it. Eventually we found it at sawmills and managed to plant our seedlings in small black plastic bags. That was the start of things and we have never looked back," she says about their journey, laden with both obstacles and victories.

The project originally took root at the University of Fort Hare nursery facilities in 2002 where Mbilase and Qongqo assumed their leadership roles and managed 11 people.

The determined two later moved to an independent site in town, but their new plot was tiny and the lack of germination rooms meant their plants died during harsh winters. Even when their bakkie was stolen and they were forced to transport water from the nearby river, they soldiered on.

They had become attached to their nursery and refused to quit. "Many others would not have been as patient as we are; our growth has been very modest. But because we experienced first hand how high in demand trees were – for urban renewal projects and in the forestry industry – we stuck to it, and our turnover reached R246 000 in 2005. In fact, we are currently experiencing that demand is outstripping supply – our nursery is too small!"

Siyatyala received a lucrative contract recently to supply 500 000 seedlings to the Department of Water Affairs and Forestry, a further 100 000 to Pirie Saw Mills, another 100 000 to a Mthatha client, plus 20 000 seedlings to Cata Forest. "We enjoy doing this, but at the moment we need to expand to be able to fulfil orders. We are doing what we can to obtain funding," she says.

They don't regret ditching their aprons for gumboots to make a living out of trees – they enjoy growing and nurturing them. "We were trained by CSIR experts and now we can do cloning, budding and grafting," they smile. "It was something new that has grown on us, and it has become part of who we are."

Siyatyala Nursery specialises in pine trees, olive, *Acacia karoo*, yellowwood and ornamental trees. "This is our *Vukuzenzele* – interpreted literally, 'wake up and do it yourself!'," they say. Before joining the Siyatyala project, Qongqo, like many other unemployed South Africans, was unable to support her family. Mbilase is a trained citrus farmer and continues to manage her farm in the Fort Beaufort area.

Thandiswa Myeki, an employee of Siyatyala and mother of three from the nearby Ncerha village, says: "This project has helped me so much; I use my earnings to educate my children and I wish the project could develop and grow bigger." Another employee, Nombulelo Tola of Gqumashe village, echoes these



"We are currently experiencing that demand is outstripping supply – our nursery is too small!"

sentiments, saying that they have worked hard to establish the nursery.

When asked about the importance of trees, they say that trees furnish human beings with two of life's essentials: food and oxygen. "As we evolved, trees provided additional necessities such as shelter, medicine and tools," say the women, adding that the value of trees continues to increase; more benefits are being discovered as their role expands to satisfy the needs created by the way people live their lives.

– Mzimasi Gcukumana

Enquiries:

Dr Steve Verryn
email sverryn@csir.co.za

“The young people of the world must be empowered to participate in the building of the information age. They must become citizens of the global information society. And we must create the best conditions for their participation.” – Mr Nelson Mandela

Cell phones to the rescue of learners


THE MOST UBIQUITOUS communications device in South Africa, the cell phone, may soon be a widely-used educational tool for learners, thanks to innovative technology developed by the Meraka Institute, a national research centre managed by the CSIR.

This development is the outcome of a research project dubbed MobilED during which the use of mobile technologies and services for formal and informal learning was investigated. Funded by the Department of Science and Technology (DST), the project was undertaken in collaboration with the Helsinki University of Art and Design in Finland and the University of Pretoria.

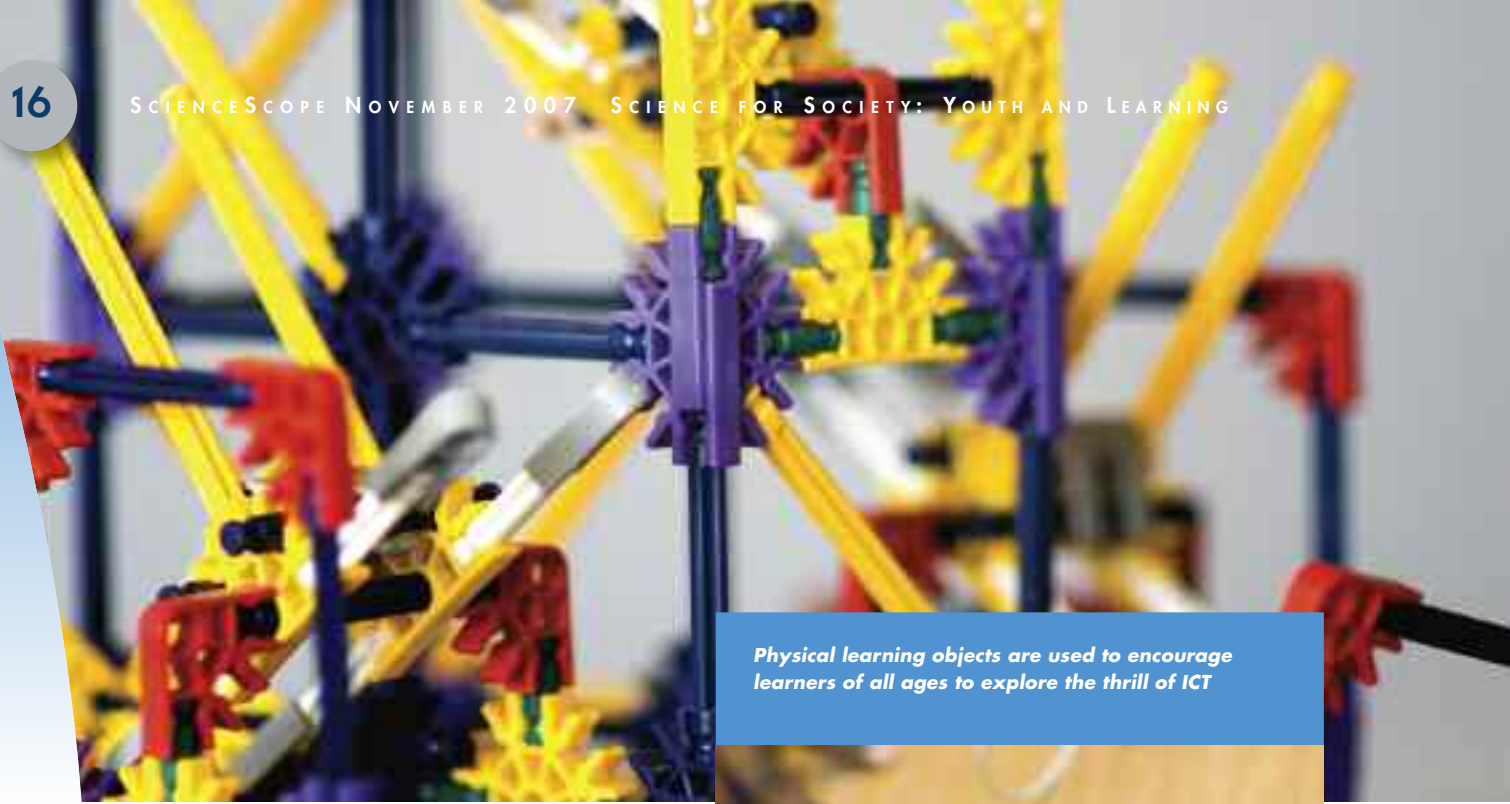
MobilED: Quick and easy access

Through the MobilED system, learners and teachers are able to use one of the most accessible, affordable computing devices in the developing world to access information resources. “Imagine a school in a rural setting, with no access to any resources,” comments Meryll Ford of the institute’s ICT for education, youth and gender research group, outlining a scenario that is not uncommon in South Africa. “With the MobilED platform, a learner may have access to information resources by sending a text message (SMS) to the service from a basic cell phone.”

The first module of MobilED enables access to Wikipedia, the world’s largest, collaboratively created online encyclopaedia. Ford sketches the steps involved in accessing Wikipedia through MobilED: A learner sends an SMS with a search term to the MobilED service number and then receives a call-back.



Two learners from Tshepagalang High School and Eletsa High School respectively, share the joy of learning through MobilED



Physical learning objects are used to encourage learners of all ages to explore the thrill of ICT

During this call, a speech synthesiser 'reads' an article on the subject retrieved from the audio-Wikipedia.

This method of information delivery has several advantages. If the cell phone is connected to speakers, more than one individual can share the information. To cater for varying levels of listening skills and comprehension, it is possible to fast forward or rewind the message. Through an important addition, one of the most significant advantages of digital inclusion becomes possible – learners can dictate information to the service to add their unique knowledge on a particular subject, which then forms part of the Wikipedia article as an audio clip. "In this way, these learners become full participants – contributors – to the information society," Ford notes.

Ford explains the different components of the system that the Meraka Institute researchers put together. A server with telephony hardware is equipped with Asterisk, an open source software PABX system. Additional software was written to intercept and process the SMS using a speech engine developed by the institute, which enables the learner to receive the audio message. Currently this is being tested in South African English. It is possible to write additional plug-ins (or software additions) to the service to enable access to any online information resource. The team is currently working on an MMS (multi-media service) content-addition and delivery module.

Schools involved in the initial pilots were Gauteng-based Cornwall Hill College and Irene Middle School. Three additional pilots



GameBlocks allow children to explore and acquire the principles of programming through play.



Laurie Burgereit, initiator of the mobile tutoring system, 'Doctor Maths'

are planned for early next year to test the innovations in classroom situations at rural schools in North West with direct feedback from the learners and teachers.

Ford envisages great prospects for MobilED in future. "It has proven that cell phones can be very useful where no other access to information sources exists. Libraries or internet connections no longer need to be the sole access point for educational information for learners," she stresses. The Meraka Institute would like to make the facility affordable to all schools in South Africa.

Sustainability models are currently under investigation. A recent visit to the United Nations Children's Fund (UNICEF) was very successful in showcasing this technology, developed in Africa for Africa.

UNICEF has already installed its own MobilED server in New York and plans to use the platform in its activities in the developing world.

Maths via MXit

The Meraka Institute has found another way to leverage the popularity of the cell phone as a communications device. A mobile tutoring system, 'Doctor Maths', runs on MXit – a popular instant-messaging service that is accessible via cell phone. By developing a new client-based platform that runs on a PC, the institute enables call-centre-like functionality for the service. Using volunteers from the University of Pretoria's engineering department, Doctor Maths offers real-time mathematics support for high school learners using the MXit chat facility on their cell phones, at a fraction of the cost of an SMS. More than three million school-going learners are subscribed to MXit and use it on a daily basis. Potentially, all of them can receive help with their school mathematics through this service.

Since the Doctor Maths service started in January 2007, with 20 learners from one school, it has grown to more than 1 000 learners from around the country. This is

phenomenal growth, given the fact that no real formal promotion of the service has been done. Ford emphasises that the institute does not advocate any particular chat engine and that Doctor Maths will be available through other chat systems as well.

Making ICT learning fun

Ford and her group are actively involved in projects aimed at learners of all ages to promote learning through the use of ICT. One aspect involves the development of physical learning objects such as Game-Blocks to allow children to explore and acquire the principles of programming, through play. These physical learning objects are then incorporated into group activities for different age groups to allow children to explore and learn skills in an informal learning environment.

– Biffy van Rooyen

Enquiries:

Merry Ford
email mford@csir.co.za



Digital Doorway
Enriching your mind

Three members of the Digital Doorway team: Kim Gush, Grant Cambridge and Sam Skosana

Ntshongweni takes a giant step into the computer age

"I wish the children, teachers, leaders and community members of Ntshongweni many happy hours of learning on the Digital Doorways we leave you with,"
– Mr Mosibudi Mangena

FOR YEARS INHABITANTS of Ntshongweni – a village sprawled across a mountainous area outside Durban – watched in anticipation as signs of civilisation passed by on the adjacent highway linking Pinetown, Pietermaritzburg and Durban.

At the coalface of abject poverty and unemployment, the residents of this community once marred by political violence, could only but dream of the luxuries of the 21st century enjoyed by many South Africans.

But thanks to the Minister of Science and Technology, Mr Mosibudi Mangena, and a planned, phased roll-out of the Digital Doorway project by his department, they are now part of the information age. Four schools and a multipurpose community centre can communicate via a chat program over the wireless mesh network. Mr Mangena officially launched the Digital Doorway in Ntshongweni on 4 September 2007.

The Digital Doorway is a joint initiative between the Department of Science and Technology (DST) and the Meraka Institute (a national research centre managed by the CSIR). Its vision is to make a fundamental difference to computer literacy and associated skills in South Africa. The Digital Doorway employs minimally-invasive education in order for people to teach themselves computing skills.

The project started in November 2002 with the first installation of a single seater Digital Doorway in Cwili, a rural community in the Eastern Cape. By the end of March 2005, 24 Digital Doorways had already been deployed countrywide. By the end of 2007, 169 Digital Doorways will have been deployed.

Ntshongweni now boasts five Digital Doorways clustered at four schools, namely Wozamoya High, Albin Girls High, Ntshongweni and Lalelani Primary schools, and at the community centre. These Digital Doorways are connected

with a wireless network. "This is an important dynamic, especially for a rural community," said Mr Mangena in his keynote address at the launch.

"It should be clear that the Digital Doorway intervention does not in any way replace the need to equip our schools with computer labs, remove barriers to accessing the internet from home or make computers affordable so that more families can own a computer." Mr Mangena said the Digital Doorway is rather an alternative mechanism that supplements computers in schools and provides access to computers to adults and children who are not exposed to these at home or at school. "I wish the children, teachers, leaders and community members of Ntshongweni many happy hours of learning on the Digital Doorways we leave you with," he said.

Although the community – including learners – have never touched a computer before, they are resolute to make good use

of it. Older people vowed that they will be jostling and bustling in the queues alongside their children to use these 'miracle' machines. "We want to learn, *imfundo ayikhulelwa*" – loosely translated, 'one never grows too old for education and knowledge', they said.

Before the official launch, people were tapping and dancing to the tune of Hugh Masekela's song "Everything must change". And indeed the change was really on their doorstep.

"We have now reached a stage where we are in a position to deliver technologies that promote the development of people. What is particularly pleasing about the technology we are launching today is that it brings benefits, which include access to learning instruments and information on a number of social development issues, as well as providing government services to both young and old," Mr Mangena said.

In high spirits, the Minister shouted development slogans, "Forward with computers, forward", which the excited Ntshongweni community echoed. Mr Mangena also emphasised that adults should make use of the Digital Doorway and added: "I would be pleased if we could install a Digital Doorway in each and every school in South Africa." KwaZulu-Natal MEC for Education, Ina Cronje, said: "It's a very happy day – our children are 21st century citizens and it is an anomaly to try to educate them using outdated tools. They need to be part of the 21st century's information era and today is bringing us closer to that."

Ethekwini Municipality Deputy Mayor, Logie Naidoo, said the Digital Doorway created a link between KwaZulu-Natal's digitally-endowed groups and the far-flung communities such as Ntshongweni. "The Digital



Mr Mangena officially launches the Digital Doorway, with eThekweni Municipality Deputy Mayor, Logie Naidoo, in attendance

When asked what they thought about the Digital Doorway installation in their community, people responded as follows:

Thomas Mketelwa (39): The Digital Doorway may even help reduce crime because it presents an alternative to aimlessly roaming the streets.

Sanelisiwe Mbele (14): The Digital Doorway is going to help me with my history studies.

Khanyisile Lafleni (15): This will help me understand what is going on around me and keep me abreast of matters.

Simiso Matiwane (44): The Digital Doorway means a lot to us. This community is hard hit by the scourge of poverty and this is going to help us access important government documents and we will also learn how to do business.

Adapting the four-seater Digital Doorway for children with disabilities has opened the digital world for Filadelfia learners in Atteridgeville

Doorway is free and provides open access – it is a smart way of bridging the digital divide," said Naidoo, imploring the Ntshongweni community to "look after this project and treat it with respect because it's here for your own benefit".

Ward councillor Themba Moyo said the project would help promote sustainable human settlement, allowing the community to become part of the information society and improving quality of life in Ntshongweni. "This project will help learners to do their homework and will also boost adult literacy," he said.

Sipho Nzuza – born in Ntshongweni some 30 years ago – has never used a computer: "We know nothing about computers here; other than cell phones, we have no knowledge about technology," he said.

Headmaster of Woza Moya, Benedict Nzama, was equally ecstatic about the newly-installed Digital Doorways, adding that out of some 800 learners, just more than 50 have computer skills. Dudu Ndlovu, Principal of Lalelani Primary, said they have started referring learners to the Digital Doorway for their research projects. "The existence of the Digital Doorway will enable our school to achieve better results at the end of the year."

Sam Skosana of the Meraka Institute said the project would entice children to venture into the world of science and technology.

– Mzimasi Gcukumana

Enquiries:

Ronel Smith
email rsmith2@csir.co.za



Willing hands assemble the 2D printed pieces of a matchbox holder cut from perspex, and press-fit assembled

FabLab:

Where imagination is just about the only requirement

FabLab – a world of endless possibilities and exciting challenges where imagination is the only limitation for almost anything to be manufactured

IMAGINE, AND A DREAM can come true. Imagine, and anything is possible. Imagine taking up a challenge, solving a problem and putting the solution to good use.

Welcome to the FabLab – the world of personal fabricators. A world of endless possibilities and exciting challenges where imagination is the only limitation for almost anything to be manufactured.

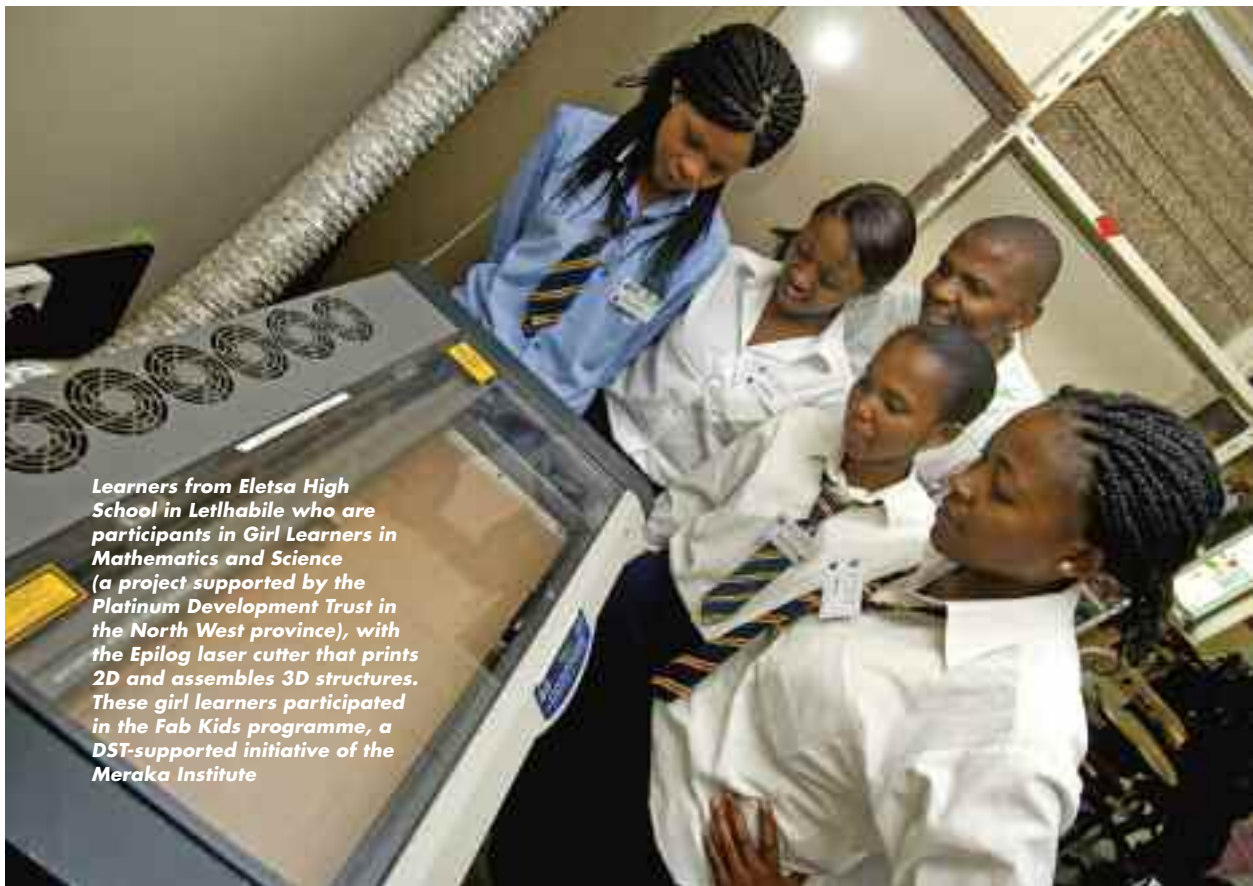
FabLab, an abbreviation for 'fabrication laboratory', is a hands-on laboratory that provides the technology to let people build just about anything from inexpensive and readily available materials.

The Department of Science and Technology (DST) enables the roll-out of FabLabs nationally through the Advanced Manufacturing Technology Strategy (AMTS) implementation unit, which is hosted by the CSIR. The AMTS earlier entered into a

partnership with the Massachusetts Institute for Technology's (MIT) Center for Bits and Atoms (CBA) to establish FabLabs in South Africa. The goal is to provide science, engineering and technology (SET) platforms for social development, while benefiting private sector competitiveness and growth.

This is achieved by bringing advanced manufacturing technology to ordinary people as an accessible platform to empower themselves by personally participating in an environment that enables the freedom to experiment and peer-to-peer learning. The platforms also provide the means to solve local problems innovatively and stimulate creativity that should lead to techno-preneurship options.

At FabLabs, a group of off-the-shelf, industrial-grade fabrication and electronics tools are used, using open source software and dedicated programs.



Learners from Eletsa High School in Lethabile who are participants in Girl Learners in Mathematics and Science (a project supported by the Platinum Development Trust in the North West province), with the Epilog laser cutter that prints 2D and assembles 3D structures. These girl learners participated in the Fab Kids programme, a DST-supported initiative of the Meraka Institute

THE FABLAB NETWORK is an arrangement where the components are connected to one another in a functional manner.

It consists of seven personal computer workstations; each FabLab has a laser cutter for 2D structures and a vinyl cutter that plots and cuts in copper and vinyl, the Torchmate Universal XYZ System for plasma cutting and cutting and engraving 2D and 3D shapes, as well as a high-resolution milling machine that makes circuit boards and precision parts.

A suite of electronic components and programming tools for low-cost, high-speed microcontrollers supports these.

The use of open source software is encouraged to ensure accessibility for all. All Fablabs are equipped with Linux and open source software. This ensures that designs and processes can be shared across the worldwide FabLab network.

The programs include open office used for documentation, presentations and mostly for drawing or computer-aided design, which is core to all FabLab tools.

Typical products that are being manufactured in a FabLab range from etching to wood and glass, model houses manufactured from perspex, solar panel design to circuit boards.


The **LASER CUTTER** uses high power CO₂ laser technology. The laser cutter can be used as a raster engraver to engrave designs onto surfaces or as a vector cutter to cut 2D designs from various material types. Both flat and cylindrical objects can be fabricated on the laser cutter, which can be accessed from any of the workstations connected to the network.

The **VINYL CUTTER** is used to cut a 2D design onto vinyl or copper sheet to fabricate circuit boards and can also be used for writing or drawing images with a pen. The vinyl cutter is operated directly from a single workstation, and not through the network.

The **TORCHMATE UNIVERSAL XYZ SYSTEM** is the most complex of all the machines to assemble and set up. The system is connected to its own workstation and neither is connected to the network. Two tool types are operated on the system, namely a plasma cutter used for fabricating designs from metallic materials and a router. The router is used for fabricating 2D and 3D designs from wood and other non-metallic materials.

The **MINI MILLING MACHINE** can perform machining operations in 2D or 3D. The machine is operated directly from a single workstation and not through the network.

In the **OPERATING SYSTEM**, six workstations are connected to the network while one is connected to the Torchmate Universal XYZ system as a stand alone. The Torchmate system utilises Microsoft Windows software, while the Ubuntu application used for the other FabLab machines runs on the Linux operating system.



A learner mounts a copper circuit board onto a 3D milling machine, to manufacture an electronic circuit

What does the FabLab offer?

AS PART OF ITS SERVICES to crafters in the province, the Cape Craft & Design Institute (CCDI) offers a state-of-the-art centre for innovation and fabrication to assist crafters in developing new products. In this way craft producers gain access to technology and resources that would previously not have been available to them. The centre for innovation encourages crafters in their innovation skills, and also provides inspiration for new trends, applications and materials.

This first craft and design FabLab in the world, situated in Cape Town, significantly enhances local product competitiveness in global markets. The facilities at the centre include the high-tech FabLab, with design software linked to digital desktop manufacturing technology; a product development clinic for one-on-one product development support, with sources of inspiration and an internet-search computer; and a resource centre for market information and documentation of indigenous knowledge and cultural heritage for inspiration.

The FabLab is visited by designers, design students and crafters and joint projects often result between the various groups. One such collaboration was between master craftsman Jim Chiota and Chris Jones, design student of the Cape Peninsula University of Technology. Chiota, a wire and bead artist, developed a new torso-light, 'Dorothy', to the designs and cross-sections that Jones mapped out using the design software.

Another item, 'Delilah', was created by Chiota in wire and beads – using the FabLab technology – as a specially commissioned piece for the AMTS FabLab implementation unit of the Department of Science and Technology (DST). Lit up and sparkling all over, Delilah made her high-society debut at the DST INSITE exhibition at Gallagher Estate in Sandton during November 2006.



The FabLab provides a facility where users can manufacture their own designs on different types of fabrication machines. Unlike other rapid product development facilities, it focuses on manufacturing of the total product.

This includes design, fabrication, testing and debugging, monitoring and analysis, and documentation of the process. The process is then shared with users at other FabLabs around the world.

FabLabs want to encourage local entrepreneurs to take their own ideas from the drawing board to prototypes and then to starting local micro businesses. Critical skills in computing, electronics, programming and CAD/CAM fabrication techniques are taught. Equipment in FabLabs is standardised to allow for common support being provided to all laboratories.

It is also a platform from which a community's technical challenges can be shared with international engineers who can help solve problems and design specific solutions for a specific community.

The FabLab concept was first introduced by Dr Neil Gershenfeld of the MIT. Today it is fast gaining popularity around the globe, with FabLabs already having been successfully established in places as diverse as rural India, inner-city Boston, Ghana and Norway.

South Africa's first FabLab was established at the Innovation Hub in Pretoria. The AMTS currently supports FabLabs in Soshanguve, north of Pretoria; Cape Town, where the focus is on craft and design; Bloemfontein; Potchefstroom; and Kimberley. More than 10 FabLabs will soon be established all around South Africa, unleashing a creative process for innovation and ingenuity to benefit the people of South Africa.

Success stories around the world testify to originality and inventiveness that have seen solutions to community problems. In Norway, a radio-tracking device allows farmers to keep track of their sheep in the Lyngen Alps, while fishermen can keep track of their boats at sea. At the Costa Rica FabLab young people are learning basic electronics and fabrication – by making functional objects with an array of sensors and actuators.

Fab Kids projects are also facilitated at some FabLabs. The project is supported by the Young Engineers of South Africa (YESA) initiative as part of the research agenda of the Meraka Institute (a national research centre managed by the CSIR). The pilot phase of the Fab Kids project is being implemented in six schools around the Tshwane area and is

aimed at instilling a love of SET among the youth. It provides an opportunity to lift the lid off education; the success of the programme has already exceeded expectations. This programme exposes children of all ages to the wonders of working hands-on in a high-tech, rapid prototyping environment.

Since all the laboratories have the same equipment and capabilities, it is possible to share digital designs and fabricated

solutions, thereby forming a network of intellectual property and exchange of ideas. A FabLab may be used by anyone of any age and no qualifications are required.

An eight-year old Ghanaian girl in a rural village proved that anyone, anywhere can make just about anything. In 2004, Valencia Kwofie from the village Takoradi crafted a working microcontroller circuit board only hours after being introduced to the concept of personal fabrication.

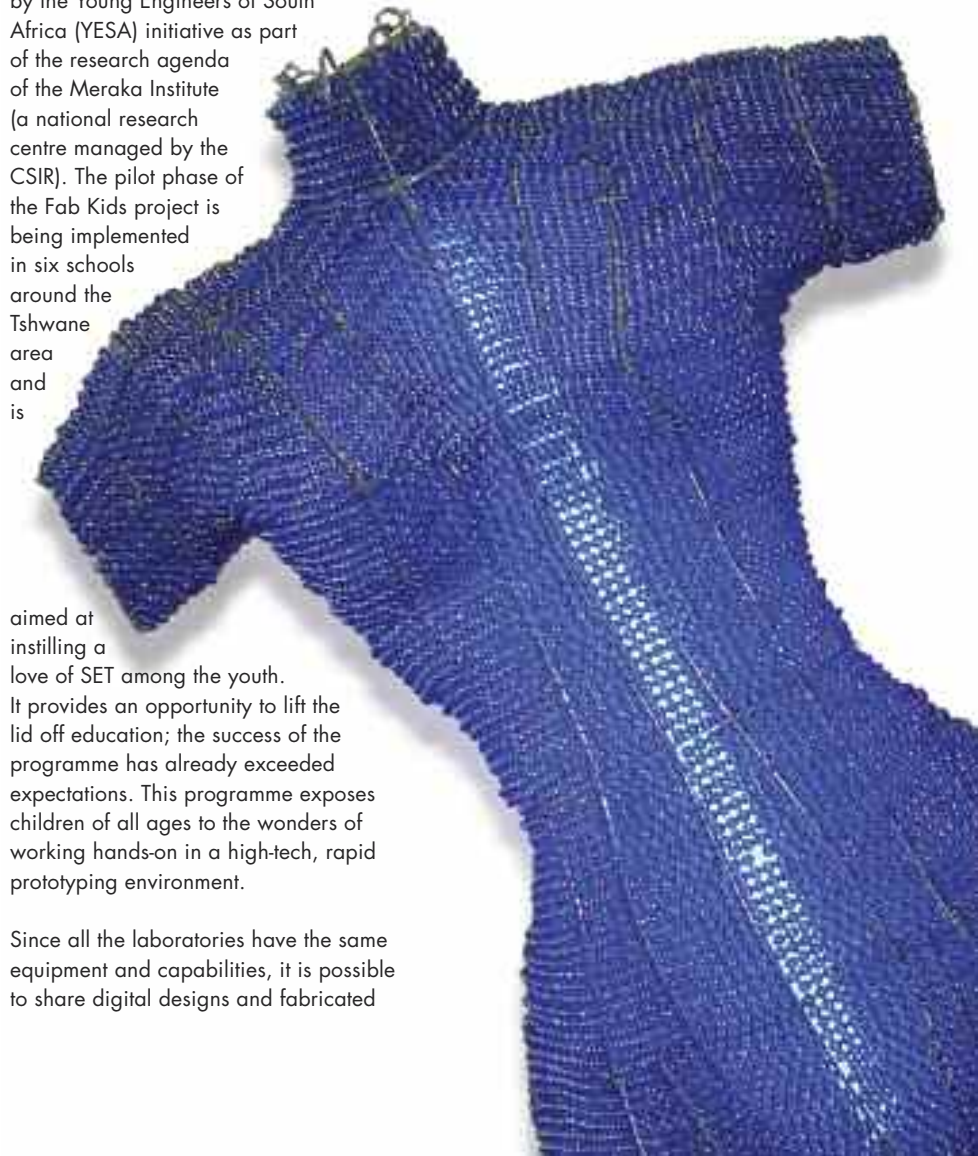
The reason? For the love of it and for the joy of discovery. – *Patsy Scholtz*

Enquiries:

Letlotlo Phohole

email lphohole@csir.co.za

'Dorothy', the torso-light, developed through a collaboration of design technology and handcraft



The pillars of Singa relate to and link the three knowledge clusters of importance to children, which have been surfaced through research: citizenship, money matters and well-being.

Enabling service discovery by vulnerable children

Michael Jenkins of metaLAB and Merryl Ford of the Meraka Institute at the SingaLAB, the living lab that is a scenario walk-through room

UNDER THE GUIDANCE of family and friends, all inquisitive children attempt to make sense of their world, learn from it, adapt it, use it and influence it. Caring adults can help create even more positive children by introducing them to empowering ideas and giving them the space to use such new information for their personal benefit. Vulnerable children must do the same, but often without reliable and long-term support structures.

Over the past three years, the Singa-zenzela partnership has worked on a child-centric, systemic change initiative that will help young people become more resilient, better able to cope with whatever life throws at them. In isiZulu, singa-zenzela means 'we can do it for ourselves'.

Called 'Singa' by the children, this ICT initiative is bold, ambitious and pan-African. It will be available to all vulnerable children, not just those who have access to digital media. The concept and subsequent ongoing development take place in a partnership between the Meraka Institute, metaLAB (a UK-based social entrepreneurship consultancy), Glynis Clacherty and Associates (child psychologist child-participation experts) and HIVAN, an organisation based at the University of KwaZulu-Natal. The Meraka Institute hosts the SingaLAB where many of the key concepts and technologies are tested with children.





The SingaLAB incorporates a range of features, including crayons, cell phones, a Digital Doorway and a mini spaza shop

To succeed, the Singazenzela intervention must be child-centric, providing children with a way forward in a manner that fits their preferences, rights and responsibilities, explains Merryl Ford of the Meraka Institute.

Singa uses a gaming approach to life that helps children and young people grasp how to make best use of available resources – to the benefit of their security, health, education and well-being. This metaphor is malleable and provides continuity, so that whatever media are available to a child can be used to make something happen.

The concept of Singa is the key to the child's experience of identity and empowerment through the use of the various mechanisms provided by the project. A Singazenzela journey is a real-life adventure, a serious treasure hunt where clues and solutions can be found using a pay phone, a cell phone, a fax, a computer or indeed, whatever the child can access, whenever it can be accessed. Radio, TV, youth magazines, newspapers and other new and creative approaches reinforce the storyline by feeding clues, tips and answers into the youth culture.

Singa is based on an evolutionary, open access and open standard platform accessible in a variety of media through any public network that reaches even the most marginalised communities. This radical approach ensures that the project can be adapted and used in a number of countries, irrespective of cultures and languages.

At the heart of Singa

Children's values have been translated into the five pillars of Singa: My World, My Game, My People, My Things and My Friend, which are blended together as a hybrid construct accessible through various media. The child can bring together into one virtual space the various fragments of life spread across disconnected physical space and time. Methods of providing children with off-line devices will ensure that the child can practice and utilise access (however limited) to affordable connectivity.

Over a period of months, by mastering various Singa challenges (found on food sacks, in spaza shops, on match boxes and on cell phones), children will make their way to the heart of Singa.

There they will find:

My World:

An environment where I have the opportunity to build and control my own safe world

My Game:

An environment where I can play, explore and learn from life's challenges

My People:

An environment where I can interact with peers, make new friends and support and learn from other children

My Things:

A safe place for digital versions of my precious and important objects

My Friend:

Someone who can be trusted, who can help me on my journey.

It is important that the child should be able to mix and match technologies to find the best fit; this is supported by the nonlinear nature of the game. Exploring

these realms builds confidence and allows children to extend horizons and initiate and manage a whole range of untested relationships with public sector delivery agencies and NGOs. The pillars also relate to and link the three knowledge clusters of importance to children, which have been surfaced through research: citizenship, money matters and well-being.

Children of the world

Further collaborators and partners are currently under negotiation. The inception phase of the project involved the creation and operation of an evolutionary prototype, based at the Meraka Institute. As a living lab, the evolutionary prototype provides:

- A range of features and services in the scenario walk-through room
- An opportunity to test the Singazenzela concept with children
- A physical, hands-on demonstration for interested parties.

Singazenzela will be piloted in South Africa, Lesotho, Mozambique and Tanzania over the next two years. Feedback from these pilots will inform how it will be further refined and adapted for use by other children and young people in the rest of Africa.

The end result of the project will be a child whose talents are recognised and who can play to strength. Through their resilience and their hope for a better tomorrow, children can learn to cope with challenges in the everyday world and access those services that are vital to their well-being.

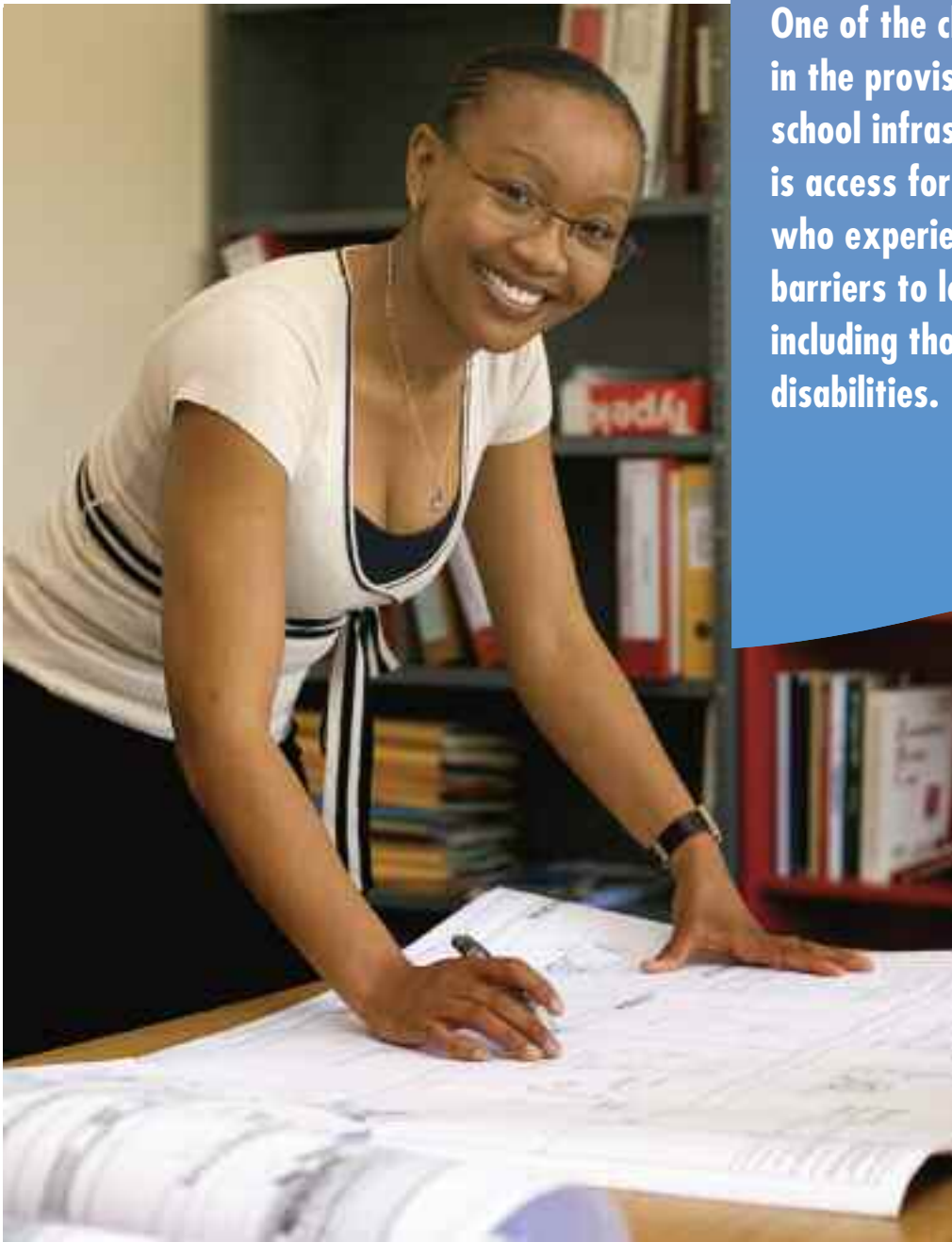
– Biffy van Rooyen

Enquiries:

Merryl Ford
email mford@csir.co.za

Creating an inclusive learning environment for South Africa's children

by Liteboho Mphutlane



One of the challenges in the provision of school infrastructure is access for learners who experience barriers to learning, including those with disabilities.



WITH THE INTRODUCTION of new education policies in South Africa, the Department of Education (DoE) faces immense challenges in the provision of school infrastructure. The challenge of building new schools and upgrading existing ones to reflect the changing education environment also offers opportunities for introducing innovative designs and implementation processes that will enhance teaching and learning in South African schools. The CSIR is providing technical support to the DoE in carrying out some of the key strategies.

One of the challenges in the provision of school infrastructure is access for learners who experience barriers to learning, including those with disabilities. In 2001, the DoE introduced a policy titled Education White Paper 6: Building an Inclusive Education and Training System. The policy seeks to address the disparities in the way education is provided for learners who experience barriers to learning, be they curriculum, language, socio-economic status, or school infrastructure-related.

One of the key strategies identified in the policy as an essential element is the design

and phased conversion of about 500 of the 20 000 primary schools in the country to become what is referred to as 'full service schools'. A full service school is defined as one that supports education for all learners, irrespective of their differences, and provides an inclusive learning environment by minimising barriers to learning in terms of curriculum, teaching methodologies and the physical environment.

In 2004, the DoE appointed the CSIR for a three-year period to manage the first phase of implementing White Paper 6 on inclusive education. This phase involves:

- The conversion of 30 ordinary primary schools, across the country, into full service schools. This is being done through the design and construction of a range of interventions to improve the accessibility of the schools, the provision of material resources – such as assistive devices and other equipment – as well as the development of human resource capacity in these schools.
- The strengthening of 30 special schools to become resource centres that will provide specialised professional support to the 30 designated

Seemingly conventional architecture can make a difference to children with disabilities attending school with ease

full service schools and other neighbourhood schools.

- The establishment of 30 district-based support teams, which are integrated professional support services teams. Their function will be to assist education institutions at district level to identify and address barriers to learning and promote effective teaching and learning.

This three-pronged approach will enable the DoE to develop an implementation plan and cost models for establishing inclusive schools in future.

As part of this project, the CSIR together with Gauge, an environmental access specialist group, has developed a manual called Full Service Schools Environmental Access Manual, which details the basic environmental access standards that have to be achieved by each primary school in order to be classified as a full service school. Subsequently, the CSIR has conducted workshops in all provinces for education planners, public works architects and teams of private sector building professionals (architects, quantity surveyors and engineers).

The workshops aimed to develop a thorough understanding of inclusive environments, the standards detailed in the manual and the requirements of White Paper 6 in relation to the physical infrastructure of schools. The workshops were highly participatory, involving experiential learning, for example through the use of wheelchairs and interactions with learners and other people with disabilities.

The next stage of the project, scheduled to run from September 2007 to July 2008, entails the construction of the environmental access interventions detailed in the manual.

Enquiries:

Liteboho Mphutlane

email lmphutlane@csir.co.za

Infrastructure indicators to improve South Africa's schools

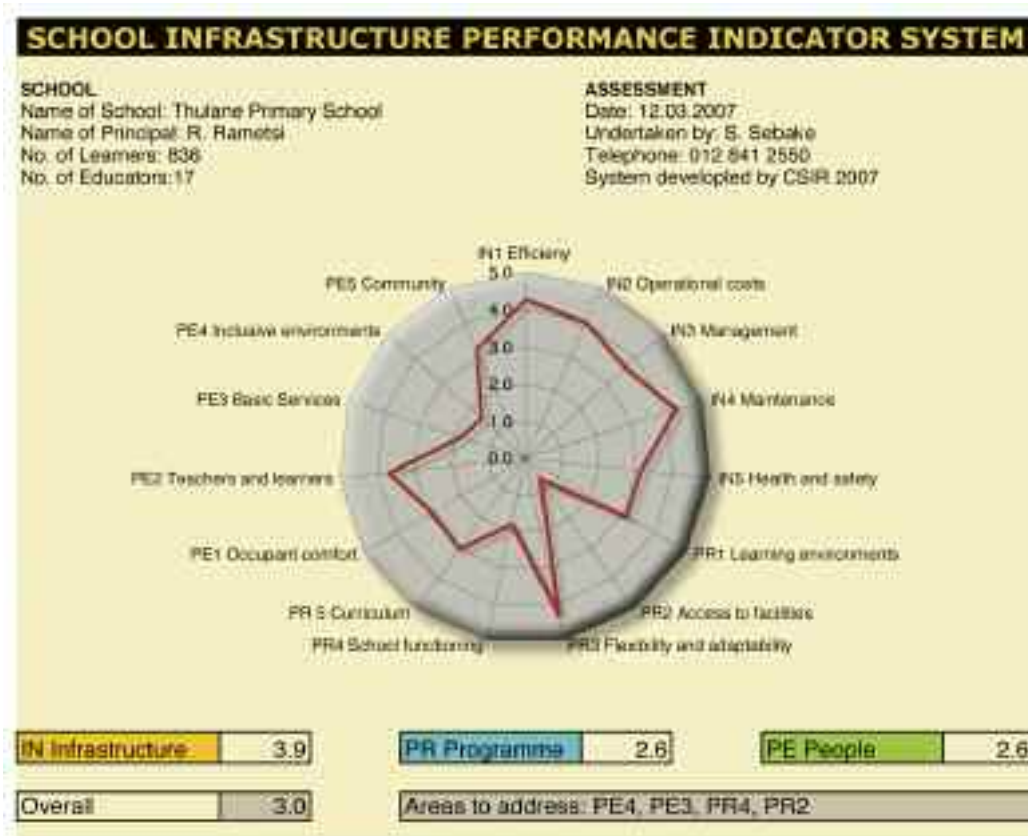
WHILE SOME SOUTH African schools have excellent infrastructure, others do not even have access to basic services such as water and sanitation. A CSIR project has identified the critical aspects of school infrastructure required to support efficient, equitable and high-quality education, and developed an assessment framework to ascertain school infrastructure performance.

According to CSIR project manager Dr Jeremy Gibberd, the vast differences in school infrastructure provision in South Africa raise a number of key questions:

- Should most resources be allocated to schools where infrastructure is poor
- How should school infrastructure be improved over time
- Which aspects of school infrastructure should be tackled first
- How can one ensure that urgent backlogs are prioritised within a framework that also ensures improved overall performance of school infrastructure over time?

The CSIR's school infrastructure performance indicator system (SIPIS) project aims to address these questions by investigating the performance of school infrastructure and establishing how to





Example of a school infrastructure performance indicator system (SIPIS) report

to 'self-diagnose' problem areas, prioritise interventions and develop solutions that not only address

measure it. "Infrastructure performance indicators systems are seen as a way of improving infrastructure as these provide a way of capturing useful information that can be used to support decision-making in infrastructure planning and programmes," explains Gibberd.

Information from assessments using specific indicators can, for example, be used to guide the prioritisation of expenditure in infrastructure capital and maintenance budgets.

The SIPIS project kicked off with a context analysis and literature review, which included a review of the national education policy. The findings indicated that South African school infrastructure planning systems have to balance the urgent need to address backlogs in basic services such as water and sanitation, with a continuing requirement to improve the quality of education infrastructure in all schools. The integrated building performance model developed by the CSIR team thus attempted to encompass these requirements by defining building performance in three areas: people, infrastructure and programmes.

The model was developed into an assessment framework by identifying an initial set of performance criteria in each area. The team then collected data on these criteria through desk studies and fieldwork, using both qualitative and quantitative methodologies such as interviews, class exercises, desk studies, assessments and observations.

"The study suggests that school infrastructure performance can be measured against 15 criteria, five in each of the areas of people, infrastructure and programmes," Gibberd explains. "Performance in each of these criteria would be established through five indicators, and can be represented graphically in a radar diagram, allowing performance to be read with ease."

The envisaged final output of the project is a system of indicators that can be used by departments of education, education physical planners and schools to develop a holistic picture of the performance of school infrastructure and identify deficiencies with ease. "The tool can also contribute to infrastructure plans developed by schools themselves, by assisting them

existing problems, but also improve overall infrastructure performance over time," Gibberd points out.

Initial findings of the SIPIS project suggest that the integrated performance model enables an approach that can be used to address both the urgent provision of basic services at schools as well as supporting the development of more sophisticated and more effective education environments over time.

Gibberd emphasises, however, that further work is required to test the indicator system, "It should be tested in schools by teachers and governing bodies to ensure that it is effective and easy to use. It should also be tested through integration into larger-scale physical planning systems such as the School Register of Needs database, to ascertain whether the indicators play a useful role in supporting the development of better school infrastructure."

– Deidre Lotter

Enquiries:

Dr Jeremy Gibberd
 email jjgibberd@csir.co.za



Co-workers Martin Pistorius, Ilse Viviers and Willem van der Walt conduct a productive meeting while Van der Walt captures content on the Notetaker. Van der Walt is blind; Pistorius is quadriplegic with a speech impairment

Creating intelligent environments for independent living

THE WHITE PAPER on an Integrated National Disability Strategy (INDS) estimates that 5-12% of South Africans are moderately to severely disabled. In addition, many other people are affected by permanent and temporary disabilities caused by accidents, illnesses and ageing. The full implementation of the recommendations of the INDS remains unachieved. In practice, millions of persons with disabilities remain excluded from the mainstream of society and the economy and experience poverty, unemployment, lack of education and training.

The Meraka Institute (a national research centre managed by the CSIR), through its intelligent environments for independent living (IE4IL) research group, is committed to using advances in information and communications technology (ICT) to assist persons with disabilities and the aged to

live independently and be active participants in society. Its two initiatives in this regard are the National Accessibility Portal (NAP) and the intelligent enabled environments project. Both initiatives aim to address the needs of groups of people who might never otherwise enjoy the opportunity to become independent.

NAP: Reaching communities

The NAP research and development (R&D) initiative was conceptualised and developed by the Meraka Institute in partnership with a representative group of disabled persons' organisations and national government through the office on the Status of Disabled Persons in The Presidency.

NAP addresses the ICT needs of persons with disabilities and their marginalisation

from the mainstream economy and society. The initiative is distinctly different from any other disability project – "Its uniqueness lies in its ability to integrate all persons with disabilities into the mainstream economy and society through the use of ICT, to facilitate access to NAP centres and affordable technologies and to provide services that promote independent living and inclusion," says project leader Hina Patel.

Since its inception, NAP has grown to incorporate a range of elements and activities, which work together to promote its aim:

- NAP centres that provide access to ICT and disability-related information to rural and disadvantaged areas
- The NAP portal that allows access to and contribution of disability-related

information on the internet

- Advocacy to address issues of policy
- The development of a sustainability model for R&D and roll-out activities within the NAP initiative
- R&D to enhance technology for people with disabilities
- The development of localised assistive technologies at low cost, open source-based and with communication interfaces
- The development of a methodology for other developing countries.

The use of open source technology has been pivotal to the Meraka Institute's successful development of the portal and assistive technologies, notably Notetaker and GNApp. Notetaker is a low-cost note taking device based on open source for people with visual

The Tokologo centre for quadriplegics in Soweto has a NAP centre up and running



Hina Patel, Dr Aurona Gerber, Ronell Alberts, Dr Quentin Williams, Dr Louis Coetzee and Riëtte Easton - committed to intelligent environments for independent living

disabilities. GNApp is an alternative augmented communication device, also developed on open source standards, which can be used by people with speech or intellectual disabilities.

Intelligent enabled environments

Persons with disabilities such as blindness and deafness, or physical, mental or intellectual disabilities, face different barriers to independent living, both in the virtual on-line world and in the physical environment. Overcoming these barriers will allow personal autonomy and active participation in society, integrated care and rehabilitation in the home. This represents complex and exciting ICT research challenges.

People over the age of 80 are currently the fastest growing group worldwide. It is estimated that by 2050, the old age dependency ratio would have risen 160% within 75 years. This has significant socio-economic implications and requires a paradigm shift in social and healthcare services, whilst presenting new requirements for social inclusion and access to public services.

Simultaneously, the complexity and lack of accessibility and usability of many ICT-based products and services present a barrier for many people.

The intelligent environments for independent living project of the Meraka Institute plans a multidisciplinary research approach to address disability in a holistic manner.

Specifically, research will focus on how people, future technologies and the urban environment can be integrated into a complex ICT-interactive system.

The physical structure and infrastructure of buildings and cities become intelligent, connected and able to respond to human psycho-physical needs through R&D into embedded technologies within the environment.

The research focus is to create an intelligent, enabled environment starting with a room and extrapolating that to other relevant environments, such as a campus and ultimately to the whole urban environment that includes homes, offices and transportation systems.

- Biffy van Rooyen

Enquiries:

Hina Patel

email hpatel@csir.co.za





Patricia Forbes

Research aims to curb effects of air and water pollution

South Africa has many contrasts, as reflected in its diversity of cultures and communities. Wealthy communities living in environments that do not pose significant health risks, with access to education, health facilities, electricity and safe water supply are juxtaposed with poorer communities who are exposed to elevated levels of air pollution and inadequate sanitation and water facilities. This poses big challenges for the CSIR's human and environmental health researchers.

Air pollution

"To understand the potential impacts of air pollution on the environment – including poor communities – one has to measure the concentrations of pollutants with effective monitoring techniques," says CSIR researcher Patricia Forbes. Research projects therefore focus on the development of novel sampling and analytical techniques, which are more cost effective than existing methods.

A passive sampler for sulphur dioxide was developed by the CSIR, which is now implemented in a number of ongoing sampling campaigns. Passive sampling has cost benefits over active sampling methods and does not require electricity, as sampling of air is based on diffusion, thus pumps are not required. Samples are taken near industrial operations and in nearby communities. In this manner, the potential impacts of emissions on ambient air quality can be assessed, and air dispersion modelling and human health risk assessments performed.

Surf water samples are taken for microbiological analysis at Richards Bay

Another example is the use of laser-induced fluorescence for the monitoring of atmospheric polycyclic aromatic hydrocarbons, which are potential carcinogens and are listed as US EPA priority pollutants. They are generated from combustion processes, including diesel combustion, incineration and biomass burning.

Combating silicosis

In 2005, the Mine Health and Safety Council (MHSC) commissioned the CSIR to undertake research on the containment and elimination of silicosis in the South African mining industry, especially in gold mines. "While research on dust exposure and control has been conducted for decades, the containment of silica particles has not yet received the required attention," says CSIR occupational hygienist Tania van Dyk.

Awareness of dust exposure and health effects is one of the priority areas for the MHSC silicosis control programme.

The project consists of three parts: dust measurement and reporting, environmental engineering and dust control, and human resources training and management.

During the first year of the project, the CSIR research team executed an assessment of the dust sources and determined the contribution of each source to the overall exposure. In the following year, tasks included the review of new technologies for breaking and moving rock with regard to potential for dust exposure minimisation, identification and assessment of the different control technologies used for each identified dust source, and development of an industry standard for assessing filtration efficiency.

"While some of this work is being continued, we also focus on piloting and evaluation of potentially cost-effective new and existing dust control methods and the development of best practice manuals for South African mines, including design components for new mines," Van Dyk explains.





Of the 48 million people in South Africa, approximately 3,3 million still lack access to potable water, while some 15,3 million people live without adequate sanitation (DWAf, 2006)



Polycyclic aromatic hydrocarbon monitoring site at a sugar cane burn



CSIR passive sampler for sulphur dioxide



Through passive sampling the potential impact of emissions on ambient air quality can be assessed

Water-related diarrhoea

Lack of access to clean water and proper sanitation is the main cause of diarrhoeal-related disease in the country. While it is not a life threatening disease, some 1,3 million children below the age of five die from diarrhoeal disease worldwide every year (WHO, 2003). In addition, HIV exacerbates the diarrhoeal disease problem.

A recent CSIR study on the burden of diarrhoeal disease aims to determine the number of people suffering from diarrhoea due to a lack of access to improved water sources. In addition, the study will assess the burden of diarrhoea in both HIV positive and negative people. "Since the economic cost of diarrhoeal disease to a country is still not known, this project would ultimately provide the data on which to base such estimates," says researcher Maronel Steyn.

It is anticipated that the knowledge created during the execution of this project could be used to motivate disease prevention strategies and help ensure the proper allocation of economic resources, enhancing the quality of life of South Africans.

Deep-sea marine outfalls

For the past 30 years, the CSIR has performed comprehensive multidisciplinary surveys to monitor the environmental impact of the two deep-sea outfalls that discharge effluent derived from Durban's central and southern wastewater treatment works.

"The surveys are founded on the four disciplines of microbiology, environmental chemistry, toxicology and benthic community ecology," says CSIR researcher Tim McClurg. "We use a robust set of tools to assess the state of the environment in the vicinities of the two outfalls and along adjacent beaches."

It is anticipated that the knowledge created during the execution of this project could enhance the quality of life of South Africans.

Because human health is a primary concern in the study, comprehensive microbiological monitoring is performed on water samples. Mussels taken along the shore are also analysed for *Salmonella* species. The objective is to ensure that the discharges present no health hazard to people using the beaches and do not impair the receiving environment.

Biological tissues present the most suitable medium for the integrated long-term monitoring of contaminants in the sea. This concept underpins the international 'mussel watch' that seeks to monitor fluxes of contaminants on a global scale. "Mussels are collected twice a year along the central KwaZulu-Natal coast and analysed for potential contaminants," says McClurg. "The aim is to reveal spatial and temporal trends in contamination and examine possible links with effluent discharge from the outfalls."

– Renatè Janse van Vuuren

Enquiries:

Patricia Forbes
email pforbes@csir.co.za

Tania van Dyk
email tvandyk@csir.co.za

Maronel Steyn
email msteyn@csir.co.za

Tim McClurg
email tmclurg@csir.co.za

Info at the push of a telephone button for southern Africa

Reliable information on services makes life easier for young mothers in rural areas

ACCESS TO RELIABLE information as part of service delivery is vital to economic development and social well-being. Two projects by the Meraka Institute's human language technologies (HLT) research group – one in Botswana and one in South Africa – are fast-tracking the delivery of service information through novel information and communications technology (ICT) interventions. The Meraka Institute is a national research centre managed by the CSIR.

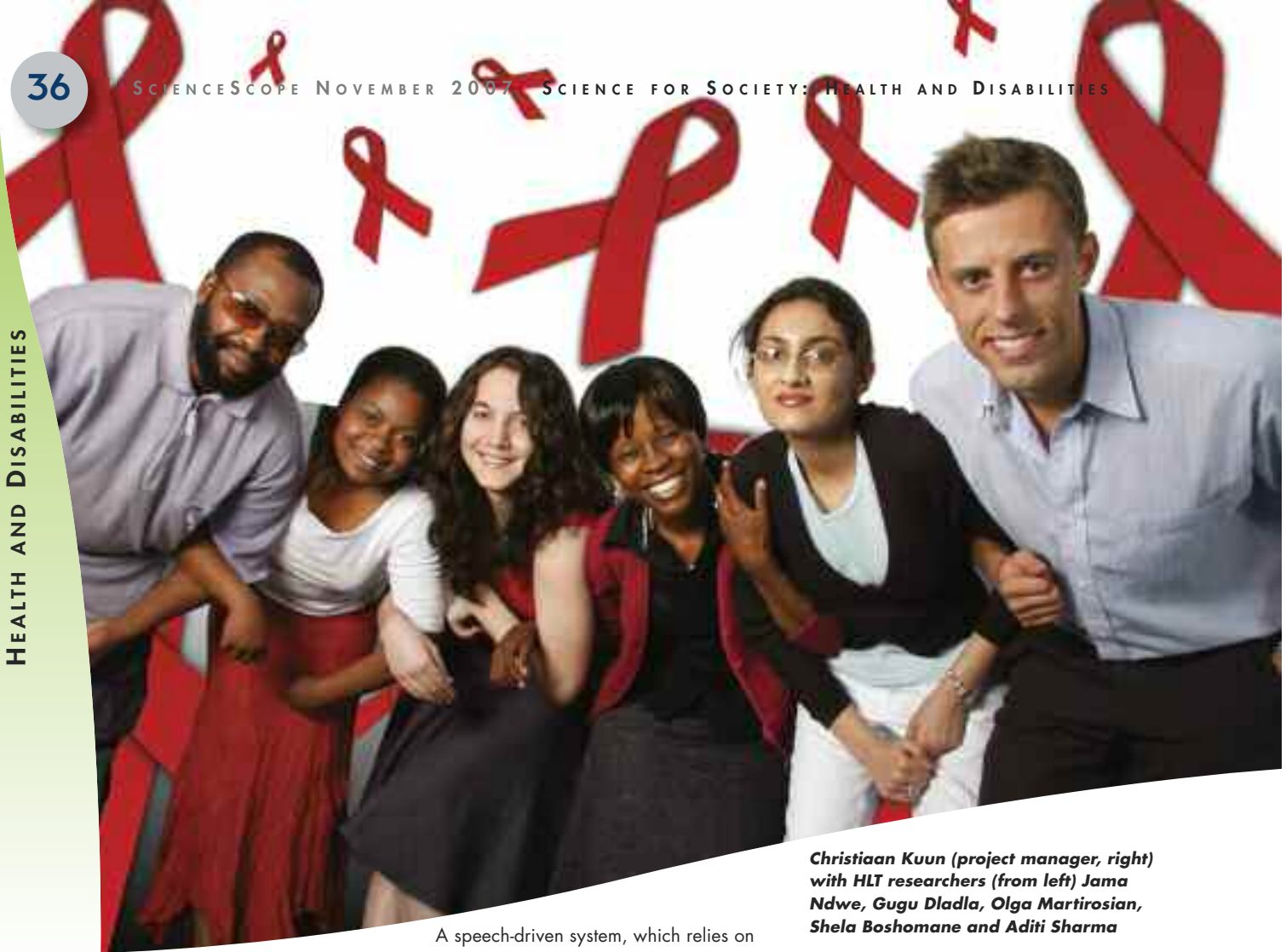
Help for HIV/Aids caregivers

Making reliable medical information available publicly via the first paediatric helpline ever in Botswana is soon to become a reality for HIV/Aids caregivers in that country. This is made possible through a partnership between the Meraka Institute and the Botswana-Baylor Children's Clinical Center of Excellence. Jointly funded by the Open Society Initiative (OSI) and the Open Society Initiative for Southern Africa (OSISA) expressly as a Southern African Development Community (SADC) project, the first pilot is expected by January 2008.

Botswana has a relatively low population of 1,6 million; at the end of 2003, an estimated 350 000 people (37,3%) were living with HIV/Aids. The life expectancy stands at 33,7 and the infant mortality rate hovers around 53-56 per 1 000. In this context, it is no wonder that an extremely vulnerable sector of the population is HIV+ babies and children (some of them orphans) dependent on caregivers.

An initial training course in primary health care involving psychologists, dieticians, doctors and other health professionals, is provided for caregivers by Baylor.





Christiaan Kuun (project manager, right) with HLT researchers (from left) Jama Ndwe, Gugu Dladla, Olga Martirosian, Shela Boshomane and Aditi Sharma

However, geographic distance, economic constraints and an urgent need for reliable and easy access to up-to-date, relevant and usable medical information all point to the need for an HIV/Aids health helpline as a dedicated ICT intervention.

The Meraka Institute's OpenPhone project holds the answer to the technology required to set up the helpline. "We are able to provide an operational, fully automated, customised telephone-based system, requiring no human resources to manage, and available at all hours," confirms project manager Christiaan Kuun. Initially, the helpline will prompt users to select numbers for access to relevant information; it also allows callers the option to leave a message requesting assistance.

These messages are accessed via health professionals who incorporate the answers to inquiries into the content of the system. The helpline can be accessed via a toll free number from public telephones or from cell phones (the latter technology is already used by the general population).

A speech-driven system, which relies on speech recognition, will be introduced at a later stage.

The OpenPhone project relies on open source software and comprises text-to-speech systems, voice recordings and speech recognition software. Verified content is supplied by Baylor and 'translated' into English and Setswana voices. The latter are created using recordings that Meraka Institute researchers have made of a Botswana-based Setswana speaker; attention to so-called soft issues ensures appropriate gender and register on the part of the speaker. Recordings are sifted; selections are made and edited to be used for compilation of relevant information. The helpline system then uses these recordings by structuring them automatically into a specific flow.

"The challenge is to build a system from the user's perspective," Kuun notes. "During our visits, we consulted with health professionals, caregivers and community mobilisers. We adapt and change the system to accommodate cultural factors and expressed preferences."

All medical information is supplied and updated by Baylor and is structured into relevant categories, such as 'general rules for caring for your child' and 'how to clean infected waste', populated with easy-to-understand content.

"The small scale of this project has allowed us to work towards a final product with relative ease," confirms Kuun. "We hope that through the learning and research involved, we will be able to introduce similar helplines in South Africa in the near future."

Access to information in all 11 official languages

A range of government information and services is readily available in South Africa. Yet for many South Africans, the challenges presented by physical distance and having to use a language other than their mother tongue, become obstacles in the quest to seek information and access services. The development of a telephone-



Jimmy-James Masalesa

based, speech-driven information system by the HLT research group of the Meraka Institute may soon make these obstacles something of the past.

The Lwazi project (meaning 'knowledge'), funded by the Department of Arts and Culture (DAC), aims to ensure that all people within South Africa's borders can access information about government services. Project manager Jimmy-James Masalesa says, "We anticipate that this system will promote service delivery by providing people with direct access to information. Queuing for information may become a thing of the past."

Given the relatively widespread penetration of telephony (both landlines and cell phones), the service will be accessed via a toll free number.

Callers will be prompted in English to either select a language or to speak. For the latter option, automated speech recognition software developed by the Meraka Institute allows the system to understand the speaker's request and text-to-speech technology allows the system to respond in the same tongue. The fully-developed system will cater for all 11 official languages.

Multiple users will be able to access the service simultaneously at any time, night or day. Information design within the system and verbal guidelines ensure that users can access the system to their best advantage through keywords. Text-to-speech software developed by the institute allows the caller to receive a synthesised voice message with the relevant information.

"During our visits, we consulted with health professionals, caregivers and community mobilisers. We adapt and change the system to accommodate cultural factors and expressed preferences."

Masalesa confirms that the pilot system for a limited user group will focus on certain prototype domains, such as health, which are of common interest. In the fully-operational system, speakers are able to interrogate the system for information about different services, such as applying for a passport, registering a vehicle or applying to register a child at a primary school. Monitoring of effectiveness is done by means of a feedback mechanism at the end of the call.

A number of collaborative pilots with government departments will be used to evaluate the effectiveness of the developed technology. Once the technology has been developed, it will be made available to individual government departments and industry as open resources. Apart from the electronic linguistic resources, developed in partnership with the North-West University through its Centre for Text Technology (C Text), the Meraka Institute's human language technologies team supplies the technology required for the system.

The team comprises computer scientists, computer engineers and linguists, as well as sociologists to ensure that human factors, such as gender preferences, are considered. *– Biffy van Rooyen*

Enquiries:

Christiaan Kuun

email ckuun@csir.co.za

Jimmy-James Masalesa

email jmasalesa@csir.co.za



Science and indigenous knowledge combine to fight HIV/Aids

SOME 40 MILLION PEOPLE worldwide are living with HIV, sub-Saharan Africa being the worst hit. The sub-continent carries just over 10% of the world population, but is home to over 60% of all people living with HIV. In South Africa alone, more than 5 million people are living with the virus. The CSIR is exploring novel, scientific interventions that may curb and eventually eradicate the spread of the pandemic.

HIV entry inhibitors

Modern medicine has over the years put its knowledge of antibodies to good use. This class of molecules has been popular for pharmaceutical and medical uses for more than three decades. When a foreign substance – such as a bacteria or a virus – enters the body, certain white blood cells produce Y-shaped proteins – called antibodies – that will neutralise the intruder (antigen). Each antibody recognises a spe-

cific antigen unique to its target, often compared to a 'lock-and-key fit'. In this way antibodies can neutralise toxins by binding with them or preventing a virus from 'docking' to its preferred receptor. Antibodies also remain indispensable in many routine diagnostic tests.

A new, powerful tool to study, treat and diagnose diseases has emerged – aptamer technology. Aptamers are artificial DNA/RNA molecules that have been engineered in a test tube. They are so tiny that they cannot even be seen with an ordinary microscope and can barely be detected with an electron microscope.

Aptamers are significant because much like antibodies, they possess the ability to bind to an antigen and prevent the virus from docking to its target. However, in the case of HIV/Aids, aptamers have specific appeal as they are able to penetrate more precisely the viral protective mechanisms

Aptamer technology, used to study, treat and diagnose diseases, has found a purpose in the CSIR's approach to illnesses such as HIV/Aids and tuberculosis.

resisting antibody attack. This promising 21st century tool that can be used to study, treat and diagnose diseases has found a purpose in the CSIR's approach to illnesses such as HIV/Aids and tuberculosis.

Microbicides in plant cells

Microbicides are compounds that can be applied inside the vagina or rectum

to protect against sexually transmitted diseases, including HIV. While there is currently no clinically validated, effective microbicide, several products are in clinical development stages.

Microbicide products – packaged as gels or creams – can act as a buffer between the HI virus and human body cells. They are tools with enormous potential. Unlike male or female condoms, microbicides are a potential preventive option that a woman can easily control, without requiring the cooperation, consent or even knowledge of her partner.

Cost, stability and ease of manufacture are critical for the effectiveness of and access to a microbicide by the poorer sectors of the population. Plants and their products have been used for centuries to prevent and cure diseases. The CSIR is conducting research to determine the suitability of transgenic plant cells in producing cost-effective microbicides. It is only relatively recently, with advances in biotechnology, that plants have been generated that can produce very specific proteins for use in human health. (These proteins have traditionally been made through microbial fermentation and from mammalian cells.) This manner of producing proteins has been loosely termed 'molecular farming': Growing and harvesting genetically-modified crops with the aim of producing not foodstuffs, but pharmaceuticals.

The advantages of pharmaceuticals produced through plants lie in product safety; reduced upfront infrastructure costs; ease of distribution; as well as being suitable for rapid and economic scale-up.

Cost-effective ARVs

Several antiretroviral (ARV) drugs, a substance that stops the activity of a retrovirus such as HIV, have been approved for clinical use in the treatment of HIV/Aids. These drugs fall into different classes based on their biological target. To date the approved therapies include nucleoside reverse transcriptase inhibitors (NRTIs) and non-NRTIs, both acting against the viral enzyme reverse transcriptase; protease inhibitors, acting against the viral enzyme protease and entry inhibitors that hinder either entry or fusion of the virus to the mammalian cellular target. The first inhibitor of the viral enzyme integrase was approved by the Food and

Drug Administration agency (FDA) in mid-October.

The CSIR initiated a project some years ago to examine mechanisms of reducing the cost of manufacturing generic ARVs. This project currently focuses on reducing the cost of preparing NRTIs by using a biocatalytic step (where enzymes catalyse a reaction) for preparation of one of the important intermediates in the preparation of drugs such as stavudine and AZT. This work is carried out under the auspices of Arvir, a company that the CSIR has formed jointly with Lifelab. In South Africa, with the number of people requiring ARV drugs estimated at more than 500 000 (where the CD4 count of the individual is less than 200), local manufacture of these drugs is an imperative.

Harnessing IK

With an estimated 24 000 indigenous plants, South Africa is well-known for the wealth inherent in its biodiversity. To boot, the country has a rich heritage in the use of medicinal plants. This link between plants and indigenous knowledge (IK) has been given new momentum over the past decade when science was added to the equation.

At the CSIR, phytochemists and natural product scientists investigate the properties of the herbal preparations and chemical components isolated from indigenous plants. Traditional knowledge of the use of medicinal plants is a key contributor to this process and is accessed through benefit-sharing agreements with holders of IK.

The scientific validation of this knowledge base has already resulted in products, for example a mosquito repellent product that has proven to be more effective than current equivalent products on the market. The product has its roots in traditional knowledge about a plant that grows naturally in areas where malaria occurs.



Traditional doctors currently use several plants for the treatment of HIV and report a vast improvement in the health of infected patients. The treatment includes herbal preparations that have antiviral effects as well as those that act as immune boosters. The CSIR is active in scientifically validating some of these claims by proving the efficacy of the plant-based remedies so that these can ultimately be developed into high-quality herbal products that are clinically safe, affordable and readily available.

This will also lead to the establishment of community-based agricultural businesses to ensure a steady supply of plant material.

Although no plant-derived drug is currently in clinical use to treat HIV/Aids, huge potential exists to identify potent anti-HIV agents from medicinal plants. Many of these may have the potential to interfere with particular viral targets, which can result in identifying novel mechanism of actions complementary to those of existing antiviral drugs. A number of natural products are commercially available for other therapeutic areas because of their efficacy and negligible side effects.

– Asha Speckman

Enquiries:

HIV entry inhibitors:

Dr Makobetsa Khati
email mkhati@csir.co.za

Microbicides in plant cells:

Dr Rachel Chikwamba
email rchikwamba@csir.co.za

Cost-effective ARVs:

Dr Moira Bode
email mbode@csir.co.za

Harnessing IK:

Dr Vinesh Maharaj
email vmaharaj@csir.co.za

Targeting malaria through a multi-faceted approach

MOSQUITOES TRANSMIT diseases to more than 700 million people worldwide. The World Health Organization estimates that about 40% of the world population are at risk from malaria. Mosquito bites cause more than 300 million acute illnesses and at least one million deaths per year. About 90% of deaths due to malaria occur in Africa and the majority of victims are children under the age of five. The South African Department of Health classifies the provinces of Limpopo, Mpumalanga and northern KwaZulu-Natal, due to their tropical and sub-tropical climate, as malaria endemic areas.

The CSIR's Dr Vinesh Maharaj and his bioprospecting team regularly deal with traditional healers claiming to have a cure for certain diseases. In many instances, such 'cures', in fact, treat only the symptoms of a disease. Some time ago, the CSIR team was approached with information on

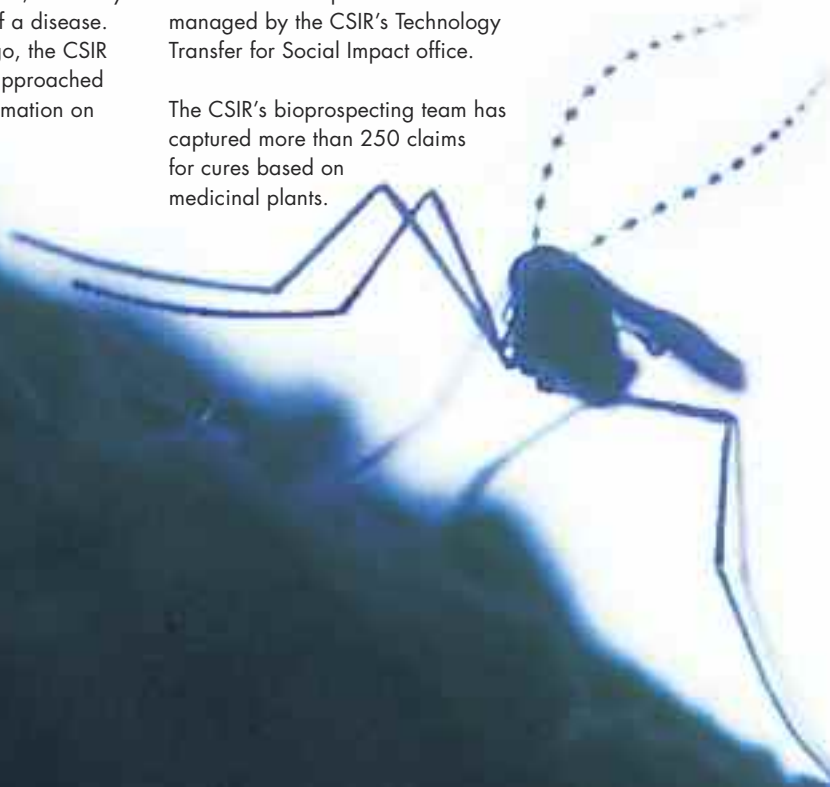
Lippia javanica, an indigenous plant and its link to the treatment of malaria. The cut branches of this plant are traditionally wiped on the skin, hung around the entrances to dwellings or thrown on an open fire at night.

Scientists subsequently conducted research on the volatile components of the plant for mosquito repellency properties. Using conventional natural product chemistry techniques and indigenous knowledge of the plant, Maharaj and his team set about extracting an essential oil, the efficacy of which was evaluated at the South African Bureau of Standards. The team developed a candle that was significantly more efficient at repelling mosquitoes compared to current products on the market. A company was established to facilitate the commercialisation of the products. This is now managed by the CSIR's Technology Transfer for Social Impact office.

The CSIR's bioprospecting team has captured more than 250 claims for cures based on medicinal plants.

From these at least 72 claims for cures were identified for which the therapeutic concepts were established for different diseases such as asthma, arthritis, malaria and HIV. According to Maharaj, 15 leads are currently in development for therapeutic areas including mosquito repellency and malaria.

Two lead compounds have been isolated and identified from medicinal plants that are traditionally used for the treatment of malaria. The compounds have shown significant anti-plasmodial activity in *in vitro* assays for both the chloroquine sensitive and resistant strains of *Plasmodium falciparum* (the parasite that causes the most severe form of malaria in humans). These are currently undergoing *in vivo* efficacy studies as part of further development.



Using a multidisciplinary approach, CSIR researchers provide innovative solutions to validating antimalarial compounds derived from indigenous plants.

Using a multidisciplinary approach, CSIR researchers provide innovative solutions to validating antimalarial compounds derived from indigenous plants. In contrast to the conventional drug discovery paradigm where the approach is to isolate a pathway and target, and use this for drug screening; the CSIR's systems biology approach studies many cellular pathways in the parasite at once. This provides deeper insight into molecular interactions in the parasite relevant to drug action.

The CSIR is a member of the Novel Drug Development Platform – a consortium of South African research institutions that are investigating antimalarial medicines from medicinal plants in southern Africa. One of the aims is to develop a comprehensive pharmacology database on South African traditional medicines with antimalarial activity and transformation of indigenous plants and knowledge into new, proven, safe and effective antimalarial treatment. To this effect the CSIR has published research papers on the screening of South African plants, as well as on the repellency and larvicidal properties of these plants.

CSIR researchers, in collaboration with the University of Pretoria (UP), the South African Malaria Initiative and the WISDOM initiative, are using the malaria protein glutathione-S-transferase (GST) as a model system for the virtual screening of a 4,6 million compound library using grid computing. GST was one of the subjects of a collaborative rational inhibitor design project between the UP, the CSIR and the Bernard Nocht Institute for Tropical Medicine.
– Asha Speckman

Enquiries:

Dr Vinesh Maharaj
email vmaharaj@csir.co.za



From plants, to oils, to candles: The making of mosquito repellent candles

AFTER TRADITIONAL HEALERS and scientists joined forces, *Lippia javanica* became one of the crops cultivated at the Hi-Hanyile project in the Giyani district of Limpopo. There the Department of Science and Technology funded the establishment of the cultivation site, a distillation plant, as well as a candle factory. This project forms part of a national roll-out by the department of sustainable community-based essential oils and medicinal plants businesses.

The candle has also since been registered for use as a mosquito repellent under Act 36 of the Department of Agriculture.

"We continue to look at product and operational improvements at Hi-Hanyile, such as the installation of a weigh bridge and agro-telemetry instruments, but the main focus now shifts to marketing the candles. This relates to both the promotion and distribution of candles. Local and international markets are being assessed and investigated," says Poloko Dibetso of the CSIR group that focuses on technology transfer for social impact.

QUICK FACTS:

The Hi-Hanyile project

- The project employs 26 people, while the factory has the capacity to produce 384 000 candles per year.
- Twenty hectares of *Lippia javanica* and 10 hectares of lemon grass are grown.
- The active ingredient originates from a selected chemotype of *Lippia javanica* and lemon grass is used as fragrance.
- A benefit-sharing agreement was signed between the CSIR and the holders of indigenous knowledge relating to the use of *Lippia javanica* in February 2003.
- The project was initiated in 2000/01 and the factory was officially launched by Science and Technology Deputy Minister, Mr Derek Hanekom and the Premier of Limpopo, Mr Sello Moloto, in August 2005.

Curbing the spread of airborne diseases

The CSIR is investigating the role of architectural engineering processes in improving the design of healthcare facilities, particularly to prevent the spread of airborne diseases such as TB.

SOUTH AFRICA FACES one of the most devastating tuberculosis (TB) epidemics in the world, with the World Health Organization ranking the country second in terms of TB incidence (or the number of cases per capita) and ninth in terms of the actual number of TB cases. In response to this challenge, the CSIR is investigating the role of architectural engineering processes in improving the design of healthcare facilities, particularly to prevent the spread of airborne diseases such as TB.

The CSIR's research, led by Dr Sidney Parsons, seeks evidence-based interventions to minimise risk within healthcare facilities. Parsons believes that architectural engineering processes can play a crucial role in designing healthcare facilities that are fit-for-purpose, especially in areas related to infection control. "Combining microbiology with architectural engineering can result in a better

The engineering sophistication of the AIR facility enables the development of scientific blueprints for the design of safer healthcare facilities





Differences between MDR-TB and XDR-TB

Multidrug resistance (MDR) emerges when there is defaulting in treatment or mismanagement of drugs. MDR-TB does not respond to standard treatments and is defined as being resistant to the main first-line drugs, isoniazid and rifampicin. It can be spread from one person to another. The cost of treating MDR-TB can be 1 000 times more than treating standard TB.

Extensively drug-resistant (XDR) TB occurs when there is resistance to all of the most effective TB drugs. It is defined as TB with MDR, as well as resistance to any of the fluoroquinolone drugs, and to at least one of the three injectable second-line drugs (amikacin, capromycin and kanamycin). XDR emerges through mismanagement of MDR-TB and can also be spread from person to person.

CSIR researcher Dr Sidney Parsons

understanding of the spread of airborne diseases," he explains.

A serious complication of the TB problem in South Africa has been the emergence of multi-drug resistant TB (MDR-TB) and extensively drug-resistant TB (XDR-TB) in all nine provinces (see box).

TB is an infectious disease transmitted from person to person by the airborne route, usually through coughing by a patient with active pulmonary TB. "Infectious droplet nuclei containing *tubercle bacilli* may remain suspended in the air for prolonged periods of time, leading to a high risk of infection in hospitals, clinics and other congregate settings with poor or little ventilation where susceptible populations – such as children and immune-suppressed individuals – may be accommodated," says Parsons.

A limiting factor to testing conventional defences against the spread of airborne TB is the inability to quantitatively culture

human-generated airborne bacteria from the air under real-life conditions because of low concentrations and competing environmental organisms. The Airborne Infection Research (AIR) facility, launched in 2005 at the HJE Schultz SANTA Centre in Witbank, Mpumalanga, was designed to address this problem.

The culmination of a five-year research project by a collaborative team from the CSIR, the Medical Research Council, Harvard University and the Centre for Disease Control and Prevention (CDC) in the USA, the AIR facility involves extraction of infectious air from patient wards to exposure chambers that house guinea pigs, which serve as living quantitative samplers of human-generated TB. Parsons, as the engineering research member of the collaborating research team, was responsible for all architectural engineering aspects of the research behind the design, development, operation and, in part, the bio-aerosol sampling techniques.

The engineering sophistication of the facility enables the development of scientific blueprints for the design of safer healthcare facilities. "The various engineering interventions necessary to curtail the transmission of infection, such as upper-room ultra-violet germicidal irradiation and other electro or mechanical interventions, can now be tested and evaluated," Parsons explains.

This unique contribution to bio-aerosol science has been recognised by the Department of Health and Human Services, the CDC and the National Institute for Occupational Safety and Health in the USA through a contract awarded to Harvard to undertake various ground-breaking research projects at the AIR facility over a period of five years, commencing in 2007.

– Deidre Lotter

Enquiries:

Dr Sidney Parsons
email saparsons@csir.co.za



Duncan Hope illustrates how the specially developed applicator of the orbital implant operates to ensure exact fitting in the eye socket

Restored
quality of
life for the

visually
impaired

ONE OF THE MOST traumatic physical and emotional experiences for a human being, the loss of an eye, need not be the end of the world for the individual. History testifies to innumerable great men and women who overcame monocular vision to become visionaries and legends in all walks of life.

Sammy Davis Jr lost his left eye in a vehicle accident in 1954 and then became one of America's greatest entertainers. Teddy Roosevelt occupied the highest office in the United States after losing an eye in a boxing game. Visually impaired athletes today continue to set world records.

Whereas eye prostheses are fairly common today, its origin is regarded to have come about by accident. In the millennia BC, artificial eye makers may not have been creating prostheses at all, but rather manufactured decorations for religious and aesthetic purposes. Artificial eyes made of silver, gold, rock crystal, lapis lazuli, shell, marble, enamel or glass played an important role in highly developed arts and a belief in the after life.

The skills of Egyptian artists were so great that they were reportedly asked to create artificial eyes for human use, especially if the afflicted were royalty. The first prosthesis to be worn behind the eyelids was invented in 1579 by the Venetians. Having been very thin shells of glass, these did not restore the lost volume of an atrophied or missing eyeball and did very little to reduce facial disfigurement. Since the edges were sharp and uncomfortable, the wearer had to remove the eye regularly to get relief from discomfort and to avoid breakage.

Against many setbacks and challenges unique to the human physique, eye prosthesis evolved slowly and the most modern and effective – the orbital implant – most popularly manufactured from the skeleton of coral, brought with it the added predicament of being costly and impacted negatively on the environment.

In South Africa, a large percentage of people who lose an eye are disadvantaged patients at state hospitals. At the St John Eye Unit at Chris Hani Baragwanath Hospital in Johannesburg, some 200 patients annually lose an eye due to orbital trauma caused by accidents, violence or disease.

According to the Society for the Prevention of Blindness, 10 000-12 000 people worldwide lose an eye annually. About 50% or more of these eye losses are caused by accidents, while a number of inherited conditions can also cause eye loss or require an artificial eye.

It was against this background that the CSIR set out in 2000, when funding was made available from the Innovation Fund, to develop an orbital implant that would be more accessible for the greater part of South African society.

The formal launch of Eyeborn® (the trade name of the product) as a commercial product at the annual congress of the Ophthalmological Society of Southern Africa in February 2004 concluded the full process from concept to successful product clinical evaluation. The development of Eyeborn® by the CSIR marked an undeniable pinnacle in the evolution of orbital prosthesis.

Eyeborn® is an innovative hydroxyapatite (HA) orbital implant used to replace the eyeball of a patient who had lost an eye. A prosthetic eye cap is fitted in front of the Eyeborn® implant, restoring the patient's appearance and improving quality of life.

The 'magic' ingredient in Eyeborn® is HA, a calcium phosphate material, which is the main component of bone and teeth in the body. HA makes up about 5% of the body weight and can be described as a 'body-friendly' mate-



Porosity of the implant is carefully engineered and controlled

rial. Ceramics synthesised from HA are bioactive bioceramics, since they naturally form an interfacial bond with some body tissue. The HA ceramic is therefore readily accepted by the body. This is in contrast to so-called biologically nearly inert material, such as aluminium and zirconium, where tissue forms a non-adherent fibrous capsule around the implant.

Orbital implant products from natural coral, the commonly used and popular material, have fixed pore size and porosity. The HA product, on the other hand, differs in that the materials can be synthesised and the porosity and pore-size distribution optimally engineered and designed.

The surface of an orbital implant produced from natural coral tends to have sharp protrusions that could damage the epithelial layer that grows over the implant, leading to infection.

An improvement in the Eyeborn® orbital implant design, which was conceptualised jointly by materials scientists from the CSIR and ophthalmic surgeons of the Pretoria Eye Institute and the University of the Witwatersrand, is a smooth front surface that does not damage the epithelial layer.

The main advantage of Eyeborn® is that it makes affordable, high-quality orbital implants locally available. Other orbital implants, especially the commonly used ones manufactured from coral, are imported at a high price and are therefore unaffordable for use in government hospitals.

The integrated prosthesis also has improved motility because of extra-ocular muscle attachment to the implant. This means that the Eyeborn® implant allows synchronous movement of the artificial eye with the normal one, with a resultant positive impact on the self-esteem and quality of life of the patient.

More than 300 patients, most of them South Africans, have received the Eyeborn® implant to date with exceptionally satisfying results. The product holds strong potential for utilisation in African countries, as well as in the rest of the world. At the launch of the product, two Eyeborn® implants had already been sold to an ophthalmic surgeon from Zambia. Eyeborn® has been awarded the CE mark, which allows international marketing in Europe and other parts of the world.

Eyeborn® has been commercialised successfully and is being manufactured by Cerdak (Pty) Ltd in KwaZulu-Natal, while VisiCare (Pty) Ltd undertakes the marketing and distribution of the product.

- Patsy Scholtz

Enquiries:

Dr Wim Richter

email wrichter@csir.co.za

Sign Language gets an ICT make-over

THE CSIR, THROUGH its Meraka Institute, is levelling the playing field for people with hearing disabilities through information and communications technology (ICT). At its inception, the institute identified Sign Language as a strategic research endeavour from a national need to create information society technologies of the future.

As work in this field progressed and partners joined, the concept of a dedicated Sign Language research hub was birthed and resulted in the South African Sign Language (SASL) laboratory. The laboratory has been in existence for 18 months and is dedicated to research in Sign Language ICTs.

"Once the scientific questions and potential developments were on the table," says Guillaume Olivrin from the Meraka Institute's intelligent enabled environments group, "We could demonstrate our unanimity with the well-known slogan 'Nothing about us without us', and get the right community partners on board. We partnered with the Thibologa Sign Language Institution to help us remain scientifically relevant and to make a significant technological impact on the Deaf community."

At a time when South Africans are encouraged to embrace diversity, the gap between Deaf and hearing people is increasing due to an obvious lack of communication. According to Deaf South Africa (DeafSA), "Deafness does not only affect the person with hearing loss, but also every person or institution with whom he or she comes into contact."

Sebolelo Nhlapo in conversation through Sign Language with a colleague





Researchers at the South African Sign Language Laboratory: Isaac Mohlamme, Busi Sibali, Sebolelo Nhlapo and Guillaume Olivrin

Thibologa – a Tswana word for ‘unblocked’ or ‘to open’ – aims to meet this challenge by enabling effective communication through the use of Sign Language.

“We are here to make South African Sign Language easily remembered and recognised as the 12th official language,” says Isaac Mohlamme, one of the three hearing disabled employees of Thibologa. Online Sign Language and sign writing training and services, interpretation services through instant video and computer literacy training for the Deaf, form part of the SASL strategy.

Says Olivrin, “Thibologa’s Sign Language expertise is invaluable. The SASL laboratory is a technical hub where we brainstorm how to put ICT to good use for the Deaf.” He explains that one of the research themes, eAccessibility, enables one to use a computer to access information in one’s own language, e.g. SASL.

An electronic society for all is the overarching theme in this research. How to build information and communication systems that cater for mainstream people, people who use Sign Languages, Deaf people and people with disabilities. “There is currently inappropriate support for Sign Languages on electronic information systems,” says Olivrin.

The SASL laboratory and Stellenbosch University are developing a ‘signing avatar’. This electronic guru is a computer-animated character that can perform basic Sign Language gestures and can be used as an output and input modality. For instance, one project is looking at ‘question answering’ a field of artificial intelligence that communicates through the signing avatar interface.

Current beneficiaries include PhD and BSc computer science students and members of the Deaf community who assist in validating the SASL laboratory’s innovations.

“Once the technology gets out of the lab, the public, and in particular those who communicate in Sign Language, will be the main beneficiaries. In addition, some mainstream technologies resulting from our research would be useful to everyone,” adds Olivrin.

Mohlamme concludes, “It is really exciting to work in this area. We are part of something new – something that will ‘open up’ opportunities for Deaf and hearing people to engage on a more equal footing.”

– Collette Vosloo

Enquiries:

Guillaume Olivrin
email golivrin@csir.co.za

Isaac Mohlamme
email imohlamme@csir.co.za



The avatar, still in prototype development, performs Sign Language gestures

According to DeafSA , nearly:

— **1,3% of South Africans are profoundly Deaf (about 500 000)**

— **3,2% of South Africans communicate in Sign Language (about 1,5 million)**

— **10% of South Africans have hearing impairments (4 to 5 million)**



Crime and public transport: Designing a safer journey

Crime affects existing and potential users of public transport in many ways.

THE NATIONAL TRANSPORT Survey in 2003 found that crime played an important role in people's decisions not to make use of certain types of public transport – it was, for example, one of the three main reasons for respondents not making use of trains in South Africa.

A recent paper by CSIR researchers identifies specific approaches to combat crime in public transport, focusing particularly on the use of planning and design interventions to reduce crime in the South African context.

Co-authors Tinus Kruger and Dr Karina Landman of the CSIR point out that the majority of poorer people live relatively far away from their places of employment, requiring them to spend a considerable amount of time travelling. "Commuters are very vulnerable to crime during these journeys; they can be victimised on busses, trains or minibus taxis, while changing from one mode of transport to another at stations, or when walking from drop-off points to their places of work or to their homes," says Kruger.

Furthermore, despite a large proportion of the population not owning their own motor vehicles, most areas are not designed to accommodate pedestrians satisfactorily. Provision is often not made for pedestrian traffic in the form of, for instance, walkways, pedestrian bridges, or adequate lighting, thus exposing the poor – in particular – to situations where they are vulnerable to victimisation.

The CSIR research results show that the relationship between crime and the physical environment is widely acknowledged, and that opportunities for crime could be reduced through appropriate planning, design and management of the environment. "Local government and public transport authorities could provide strategic direction at a city scale by formulating spatial development policies, strategies and programmes aimed at incorporating the transport system into the city in such a way that crime problems are addressed at a city scale," Kruger explains. "This could involve the provision of suitable guidance regarding the location of major modal inter-

changes, the development of mixed nodes, and activity corridors that incorporate multiple modes of transport."

Strategic planning decisions made by city authorities could also have important direct or indirect crime reduction consequences. For instance, a strategy aimed at reducing vacant land – such as transport reserves – would remove environments that are often conducive to crime.

Closely related to these strategic level interventions is the issue of spatial and urban management. Infrastructure maintenance could, for example, be an important crime reduction mechanism; a lack of maintenance could very well be the reason why certain crimes occur in specific areas or why people feel vulnerable in a particular area.

The public transport environment includes not only vehicles such as trains and taxis, but also the facilities where passengers embark and disembark,



Since crime problems are experienced by commuters along their entire journey, a comprehensive, multi-agency approach is required

“The development of a sustainable, efficient and effective public transport system is to a large degree related to the levels of safety experienced by commuters.”

the areas where they change from one mode of transport to another or walk to or from their destinations.

Research indicates that the design of the different components of the public transport system could have a substantial impact on levels of safety as well as feelings of vulnerability. Certain environments can impart a feeling of safety, while others can induce fear, even in areas where levels of crime are not high. The form and character of the built environment as it relates to public transport can be of great significance as the local setting of a crime, either increasing or reducing opportunities for crime.

Physical design could play an important role in the creation of pedestrian-friendly environments and in increasing levels of safety. Examples of such design elements include the identification of preferred routes leading to and from public transport facilities and the establishment of a pedestrian route network; providing clearly marked routes, exits and entrances to assist in preventing people from wandering off into unsafe areas; and providing clear signage to assist users in orientating themselves and in finding their way.

The design of buildings and other structures could further contribute to reducing crime by maximising opportunities for natural surveillance. Sufficient and appropriate lighting could play a critical role in creating safer environments in and around public transport facilities, and in certain situations the use of surveillance technologies such as closed circuit television can greatly assist with reducing crime.

“Given the renewed attempts at improving the South African public transport system, and the fact that crime is a key concern in the country, it is of critical importance that any transport strategy has a specific focus on measures aimed at reducing crime in the system,” says Kruger.

“The development of a sustainable, efficient and effective public transport system is to a large degree related to the levels of safety experienced by commuters.

“Our research suggests that a much stronger focus should be placed on assuring commuters of a safe and secure journey. Since crime problems are experienced by commuters along their entire journey, it is clear that a comprehensive, multi-agency approach is required.”

Kruger and Landman point out that a range of role players could make significant contributions on various levels in developing a reliable and safe public transport system in South Africa. Opportunities to contribute exist in the fields of research, policy and strategy development as well as implementation.

Research into crime in public transport could provide valuable data regarding the nature and extent of the problem as well as possible responses to reduce incidences of crime as well as levels of fear. Research-based evidence could play an important role in directing policy, strategies and implementation, both at national and local levels.

Comprehensive national policies and strategies could provide much-needed

guidance and aid the coordination of attempts to increase levels of safety in public transport. In addition, context-specific, local-level strategies that are integrated with other local strategies and development plans are critical in addressing crime problems holistically. “To be effective, community safety initiatives need to also address crime on public transport as this impacts the wider community,” Landman comments.

Kruger and Landman clearly demonstrate that interventions in the physical environment could make a significant contribution to providing a safer journey as envisaged in the South African public transport action plan. Appropriate planning, design and management initiatives, combined with law enforcement and social crime prevention approaches, are sure to contribute to a reduction in the levels of crime as well as the fear of crime.

What is clear, though, is that the provision of a safe journey should be regarded as a non-negotiable priority, demanding a concerted effort by all role players including national government departments, transport authorities, municipalities, the private sector and commuters.

– Deidre Lotter

Enquiries:

Tinus Kruger

email dkruger@csir.co.za

Cell phone alerts

warn about weather and fire threats

FOR THE ANCIENT GREEKS, our physical world comprised four basic elements: Water, air, fire and earth. Although our scientific understanding has subsequently advanced to discover a myriad elements, the archetypal qualities of water and fire remain, representing among the most devastating threats to humankind and our environment. Thanks

to the ingenuity of researchers at the CSIR, South Africans can receive timely warnings of active fires and severe weather systems via the cell phone.

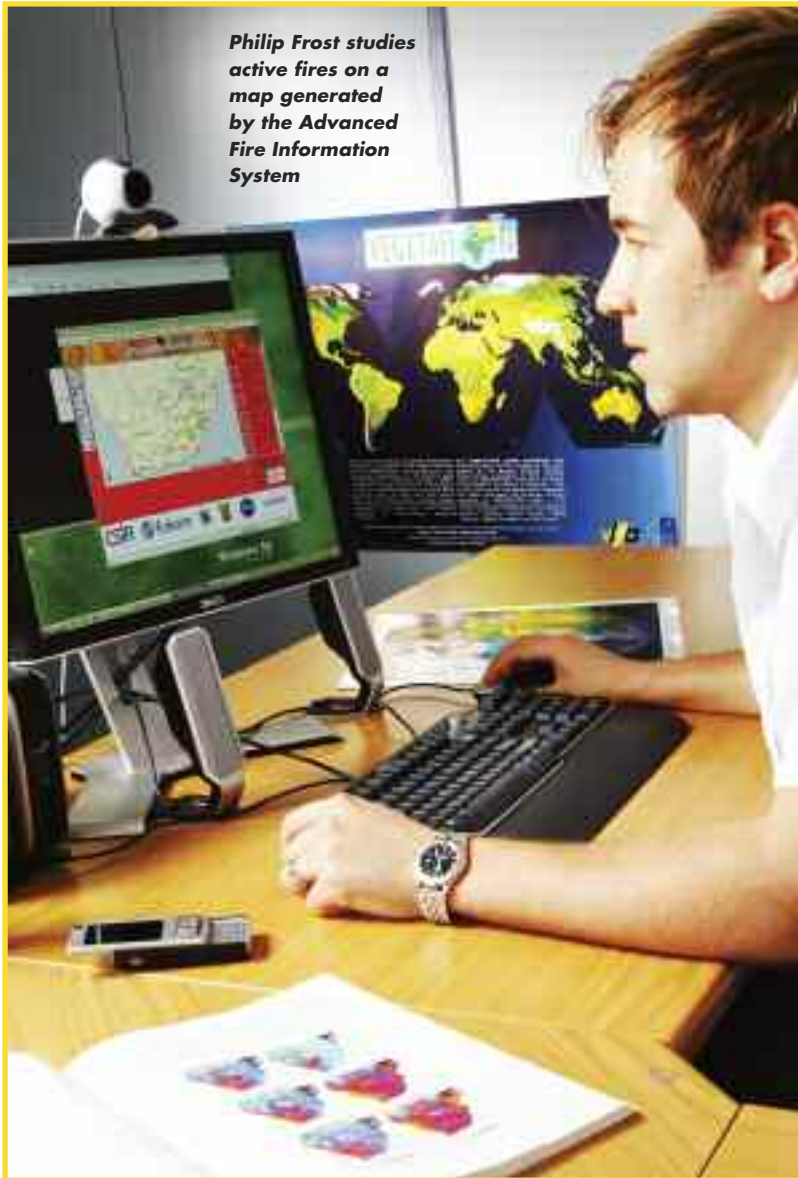
Where there's smoke ...

Veld and fynbos fires in southern Africa during the dry seasons account for costly

damage to human life and settlements, infrastructure, land cover, stock and game annually. In partnership with Eskom, the University of Maryland and NASA, and with funding from the Department of Agriculture, the CSIR has developed the advanced fire information system (AFIS) to pinpoint fires in near-real time over southern Africa.

The technology demonstrator – or personal digital assistance animated weather system – provides near real-time information on clouds, rainfall, wind and fire.





Philip Frost studies active fires on a map generated by the Advanced Fire Information System

Active fires are detected using data from the moderate resolution image spectro radiometer (MODIS) sensor on NASA's Aqua and Terra satellites. AFIS determines the exact location of active fires on a map (each dot on the fire map shows an active fire varying in size from 200 m to 1 000 m) and sends a text message (SMS) to allow Eskom to respond quickly to fires in the proximity of transmission line to reduce damage and power supply disruptions. This application of remote sensing coupled with cell phone technology for alert messaging, or SMSs, is the first of its kind in the world.

The benefits of AFIS have gone beyond that of a dedicated warning system. An agreement between the CSIR, Eskom and the South African Broadcasting Corpora-

tion (SABC) determined that fire maps based on data supplied by the CSIR and Eskom be broadcast free of charge, for viewing as part of the television weather bulletin. On 7 June 2006, the SABC became the first public broadcaster worldwide to show active fire maps.

These appeared on both SABC2 and SABC3. Based on CSIR-supplied fire location information, maps are produced by the SABC and have since been broadcast once a week (with brief interruptions due to programming changes) to viewers as an alert to the presence and prevalence of fires throughout the country.

A recent software upgrade of the AFIS system has made it possible to send SMS alerts to a range of recipients. Comment-

ing on this development, researcher Philip Frost of the Meraka Institute (a national research centre of the CSIR) notes, "It is now possible for the AFIS system to send SMS alerts to registered fire protection associations (FPAs) countrywide." This puts valuable information on the location of fires into the hands of officers within these voluntary organisations, which in turn coordinate fire fighting efforts with those of Working on Fire of the departments of Water Affairs and Forestry and of Environmental Affairs and Tourism. Members of FPAs (such as farmers and other affected parties) delineate regions and determine boundaries within which each association takes responsibility for fire fighting.

The FPA alert determines the location of the fire in relation to the polygon, which is the reference point in the region:
Terra, 14,5 km, N, Kroonstad, 14:55 SAST

Weather watch

The Meraka Institute partnered with the University of Wisconsin-Madison in the development of a technology demonstrator that allows people to access satellite information on weather conditions through their cell phones. The technology demonstrator – or personal digital assistance animated weather system – provides near real-time information on clouds, rainfall, wind and fires.

The system was developed by the space science and engineering group of the University of Wisconsin-Madison, while the Meraka Institute has been playing a key role in customising the product for South and southern Africa and providing local information. – *Biffy van Rooyen*

Enquiries:

Philip Frost
email pfrost@csir.co.za

The Eskom cell phone alert contains cryptic but accurate information to lead fire fighters to the exact location of fires in the vicinity of transmission lines: MSG, 1,04 km, NW, 2CMN/ CHV223, 08:00 SAST (satellite, distance from line, direction to closest pylon, line name and pylon number, local time of detection).

CSIR technology reduces after-war fatalities



WHILE SOLDIERS AND

civilians share the horrors of war during conflicts, it is the deadly legacy of war that causes more misery and death after the guns have fallen silent, especially amongst civilians who have to start their lives over again in war-ravaged areas.

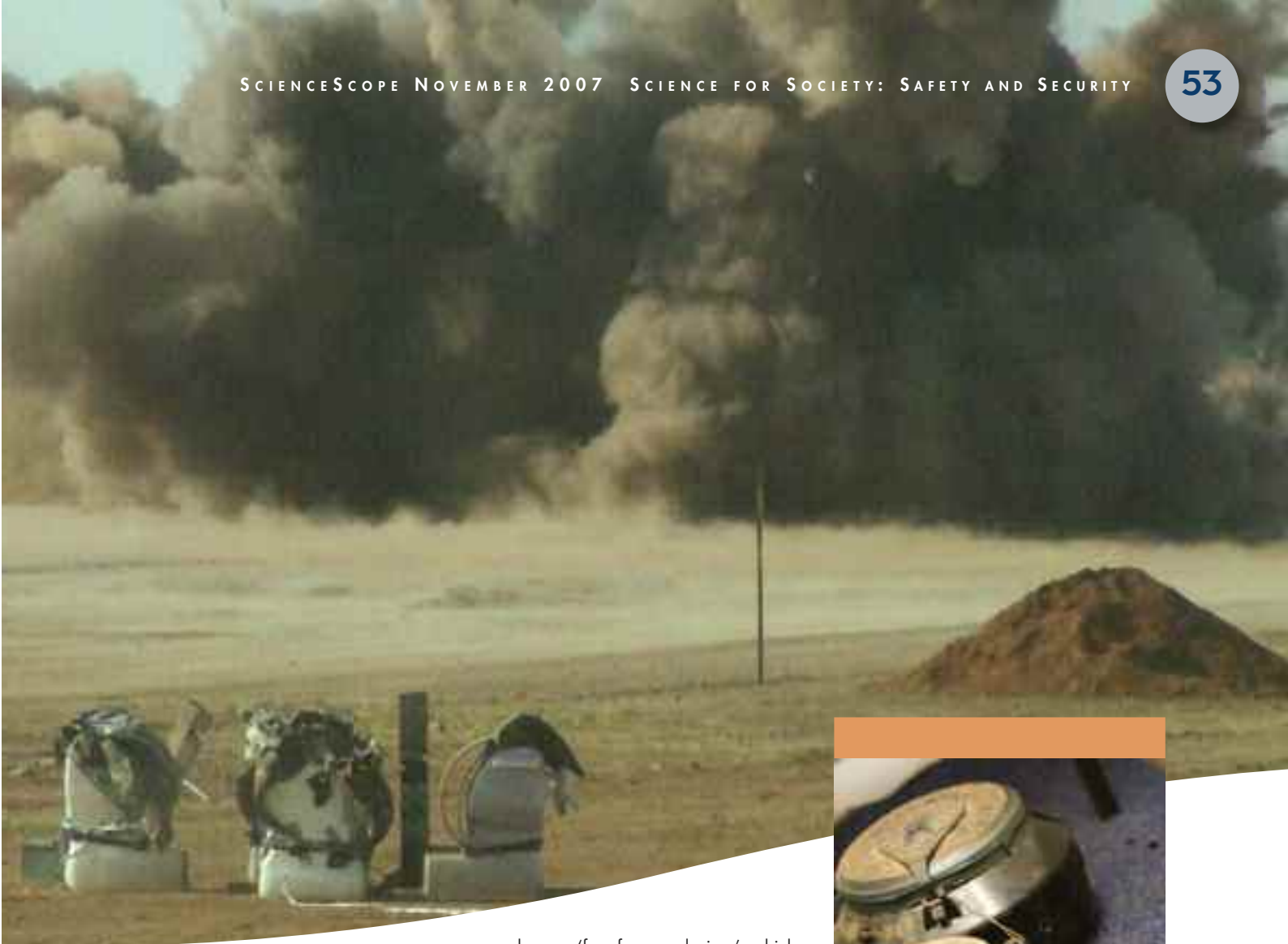
Buried landmines, unexploded ordnance (UXO) and abandoned ordnance (AXO) litter the former combat zones and their harvest of death and mutilation continues. An estimated 80 million landmines are still buried in at least 84 countries worldwide.

War and conflict have been part of the history of Cambodia and other African countries. Consequently, Cambodia is littered with mines, UXOs and AXOs, resulting in more than 3 000 incidents annually that have resulted in loss of life or limb. In Cambodia alone, it is believed that between 2 000 and 3 000 people died every year from landmine-related incidents prior to the introduction of CSIR technology in collaboration with the United States-based Golden West Humanitarian Foundation (GWHF).

The CSIR concluded an agreement during 2004/05 with the GWHF, in terms of which the CSIR would assist the Foundation to establish an explosive harvest programme in Cambodia in collaboration with the Cambodian Mine Action Centre (CMAC). The project was funded by the US State Department.

The CSIR-designed technology has significantly reduced fatalities caused by the by-products of war. "We will make a major difference in Cambodia," says Theo van Dyk, senior researcher at the CSIR.

Theo van Dyk



Although the CSIR does not render humanitarian demining and peace support as such, Van Dyk says the organisation has a key role to play in research and development (R&D) in this domain.

To the destitute local population trying to carve out an existence under these harsh conditions, the munitions and aerial bombs – including cluster bombs and napalm tanks – are attractive sources of scrap metal. “Untrained locals often defuse and dismantle UXOs and AXOs, removing the explosives to sell the metal as scrap metal, thereby gaining an income for their families. It is a very dangerous process and accidents occur virtually constantly,” says Van Dyk.

The approach was to establish a safe process for the defusing and dismantling of the UXOs and AXOs, followed by the removal of the explosive charges in order to give the remaining metallic components back to the rural

populace as ‘free from explosives’, which can be sold as scrap metal.

The CSIR technology, called ‘Steam Plant’, utilises a low-pressure steam boiler and pipe and valve system to control the flow of steam required to melt trinitrotoluene (a high explosive known as TNT). The CSIR was responsible for the design and development of the steam plant. After removal, the melted explosives are cast and pressed into smaller demolition charges and used to destroy mines located during the demining activities conducted in the country.

As part of its technology transfer efforts, the CSIR currently assists the forensic explosive unit of the South African Police Service with mine awareness training that will enable the unit to undertake projects similar to Operation Rachel in neighbouring countries. The operation, launched in 1995 as a united Pan African effort within the Southern African Development Community region, tackles the problem of small arms proliferation.

– Mzimasi Gcukumana



Enquiries:

Theo van Dyk

email tvdyk@csir.co.za



Crime prevention toolkit



Crime prevention technology sheds light on underlying problem

by Barbara Holtmann

COMMUNITIES IN THE Central Karoo, like so many others, long for a peaceful life, where children play safely in the streets and men and women, old and young, move freely and without fear, day or night.

The CSIR's crime prevention research group was commissioned by the European Union on behalf of the South African Police Service (SAPS) to facilitate the development of a local crime prevention strategy for the Central Karoo District Municipality. The intention was that the learning achieved in the central Karoo could be used elsewhere in the country, particularly in rural contexts.

The study required widespread consultation with local communities and the people who delivered criminal justice and related services to them. The CSIR used its local crime prevention toolkit methodology and started by asking people to imagine 'what it would look like when it's fixed'. Workshop participants were asked to paint or draw images of a safe central Karoo. From the elements that made up the images, the

CSIR was able to identify the key activists and actions that would be required to move towards the achievement of a safe community, village, town and district.

Typically in this exercise, people paint a utopian place, free from burglar bars and drunken brawls, where children play safely in the streets and old and young, men and women are free to move about day or night. What was significant in this instance, however, was that participants could not imagine life without the oppression of alcohol abuse. They drew liquor outlets with rows of taxis waiting to take inebriated people home; they drew crèches where children were looked after while their mothers were out drinking. This helped identify alcohol abuse as one of the biggest contributors to crime and violence in the district; CSIR researchers ensured that their investigations drew out information about the relationship between alcohol and unsafety in the central Karoo.

The police confirmed that over 90% of crimes were related to alcohol abuse. In one of the small towns with a population of

less than 7 000 people, there were 64 known illegal outlets for the sale of alcohol. It is understood that alcohol is often purchased with social grant money – and as the illegal shebeen owners were often also micro-lenders, many people were, in fact, paying huge interest on their alcohol consumption. In line with data elsewhere in the country, the connection between alcohol abuse and victimisation was clear.

Alcohol also makes people very vulnerable; young girls became vulnerable to rape as a result of getting drunk, very often in illegal shebeens where underage drinking is allowed. The area also records one of the highest incidences of foetal alcohol syndrome in the country, and indeed, in the world. Babies born to drinking mothers are at a disadvantage that they are unlikely to overcome in their lives.

The CSIR study found that many people in the central Karoo felt no particular purpose in the society. The study also revealed that young men were problematised and characterised as 'dangerous and without usefulness', while business people resisted



expanding their businesses as they felt that young people were unmotivated and unreliable; once again alcohol was to be blamed as an indicator of a lack of interest in working and progressing. There is a fear that drugs are becoming more prevalent, that underage children in shebeens are encouraged to take drugs and to sell them in the local schools. Child prostitution is also linked to the sale of drugs and to the need of children to support their drug habits.

In collating the findings, CSIR crime researchers began to map the context for crime and violence and the life cycle that perpetuated crime and violence. Findings suggest that children who were neglected and abused quickly learned to fend for themselves and tipped over into offending

behaviour, since there was poor supervision and a lack of satisfaction of basic needs.

While it was possible to ignore the needs of children as vulnerable victims – and it seemed that for the most part their needs were ignored – once they tipped over into offending behaviour, they became a problem for the police and the community demanded that the police should act against them. Young people engaged in risky behaviour of all kinds, including sexually risky behaviour with the result that young girls moved to the top of the cycle as mothers, perpetuated the cycle.

Notably, many of the recommendations were in the social arena rather than the criminal justice domain. As a result, the

The police confirmed that over 90% of crimes were related to alcohol abuse. In one of the small towns with a population of less than 7 000 people, there were 64 known illegal outlets for the sale of alcohol.

CSIR engaged the departments of Social Development, Sports and Recreation, Arts and Culture, Health and Education, at least as much as the SAPS or Department of Justice. The study provided excellent insights into the need for a broad and inclusive strategy for safety, rather than a security-based strategy.

It is essential that the criminal justice system be transparent, fair and accessible – and the study offered recommendations in this regard. But the study also demonstrated that without education, health and welfare, the toxic stranglehold of alcohol abuse on the community would not be broken. In addition, it demonstrated that community involvement was essential in both understanding the problems and finding solutions.

The models flowing from the study have been used in training SAPS members in crime prevention and are constantly being refined through exposure to other environments and research. Wherever the CSIR uses these models, service providers and community members recognise their communities in them and add learning and value to their ability to drive strategies that will help make South Africa safe.

The key advocacy message coming from the study is that we should intervene for our teenage pregnant mothers today to support them to be better mothers so that in 15 years' time, their daughters are not pregnant and we need not fear their sons as violent criminals.

Enquiries:

Barbara Holtmann
email bholtmann@csir.co.za



Naledzani Mudau

Determining the lay of the land through remote sensing

THERE IS NO DOUBT that the political will exists at both provincial and national government levels to provide services to all South Africans. Effective delivery of basic services (such as electricity and water) and urban planning are dependent on the availability of capacity and resources as well as reliable data for planning.

With the aid of geo-referenced data supplied by the CSIR, by which specific dwellings and settlements can be mapped at specific locations or areas, better planning by provincial and national service providers can be achieved to expedite the provision of basic services and urban development.

One dot per house

The CSIR is mapping the location of dwelling units for the whole country using SPOT 2,5 m high-resolution multispectral satellite imagery acquired over the period 2005/06. Although the fundamental purpose of the exercise is to quantify the existing electrification backlog for the client, Eskom, the points representing the location of dwelling units will also be an invaluable planning tool at regional level. "Each

dwelling will be marked by a dot or point, or a polygon for dense areas," confirms Naledzani Mudau, CSIR remote sensing specialist and project leader. A polygon is a figure with many angles or sides.

Once captured, point and density polygon data (i.e. points representing the location of dwelling units or polygons for dense areas such as dense informal settlements) will be analysed against proclaimed land, which is essentially land that is electrifiable and which includes areas with existing Surveyor General (SG) cadastral coverage as well as tribal lands and non-proclaimed land (areas outside of tribal lands and without SG cadastral coverage). SG cadastral coverage is like a map with boundaries and ownership of land parcels.

This geo-referenced dwelling frame will become the sampling frame for household surveys and the frame for conducting population and housing censuses in South Africa, similar to the business frame supporting economic surveys and censuses. A quality census starts with knowledge of the whereabouts of all dwellings in the country, which enables every household to be visited. "In this way, we can ensure that

every person in all parts of the country is counted," states Mudau.

These data will provide the exact locations of all dwellings and will be used for the delineation of enumeration areas, for the list of dwellings against which census data are collected, and for matching and cross-checking processed census records in the census post-enumeration survey.

The geo-referenced dwelling frame has numerous benefits. Addresses can be provided for postal delivery by the South African Post Office, while an authoritative address register will be at the disposal of departments such as Home Affairs. In this way, the public will be able to meet the requirements of the Financial Intelligence Centre Act (FICA), thereby becoming eligible for, for example, banking facilities. Service delivery of local municipalities can also be improved.

Informal settlement upgrading

The North West Informal Settlement Upgrading Programme (NWISUP) facilitates upgrading in that province through a new,



Dwelling points of Makonde, outside Thohoyandou in Limpopo, each marked with a red dot



Example of an informal settlement (delineated by a red polygon) on the outskirts of Rustenburg

phased approach. This will deliver security of tenure, municipal engineering services, social and economic amenities and housing opportunities. *In situ* (i.e. on site) upgrading is the preferred option; relocation remains an option only where circumstances dictate it.

"Currently there is no reliable information regarding informal settlements in the province," cautions Mudau. As the successful implementation of the NWISUP will to a large extent depend on the quality and effectiveness of planning, the

availability of reliable and high-quality data for such planning is imperative. Such plans will in turn be influenced by the quality and reliability of available data. As a first and urgent step therefore, a needs assessment exercise will be conducted to lay the foundation for the NWISUP.

The CSIR provides satellite imagery, both current and historic. "Our primary role is to create a current, reliable and functional database on informal settlements in North West using 2005/06 SPOT 2,5 m natural

The geo-referenced dwelling frame will become the sampling frame for household surveys and the frame for conducting population and housing censuses in South Africa.

colour images, and assess trends and determine projections of the extents, nature, age and geographical distribution of informal settlements through time series analysis," says Mudau.

"A 2006 baseline informal settlements database is created from 2005/2006 SPOT 2,5 m images," says Mudau. "Through our ability to extract data over time, we will go back to 1994 and identify and analyse those areas on the 2006 baseline. Very high resolution images like Quickbird and aerial photos will be used to count the number of dwellings."

Further aspects of the project entail integration of Statistics South Africa census data and extrapolation across the time series, as well as change analysis and detailed projected future dwelling inventories.

– Biffy van Rooyen

Enquiries:

Naledzani Mudau
email nmudau@csir.co.za

Inclusive cities in South Africa: Towards mixed communities of medium density

by Dr Karina Landman



THE DEVELOPMENT OF MORE sustainable and affordable housing remains a huge challenge in South Africa. Across the world, medium-density mixed housing is becoming increasingly popular to address this challenge and enable a range of stakeholders to contribute to the development of sustainable, mixed communities.

Various interpretations of medium density exist; broadly speaking, it includes housing consisting of a minimum of 50 dwelling units per hectare (du/ha) and a maximum of 125 du/ha. This type of housing is generally characterised by all or a number of the following aspects: Ground level entry to the unit; dwelling type with private, external space, such as a small private garden, patio or balcony; dwelling type with direct or close proximity to secure parking; and being ground-related, i.e. not more than three to four storeys above ground.

Mixed housing refers to developments with all or most of the following characteristics: Mix of building, dwelling or unit types; mix of tenure forms (such as ownership, rent-to-buy and rental units); mix of income groups (facilitated by affordable housing and market-rate housing in the same development); and a mix of land uses (such as residential, commercial, public-open space and business).

International studies indicate that medium-density mixed housing, when adhering to

a range of critical success factors, not only has a positive impact on the quality of the built environment, but also has a huge social impact, including the potential for interaction between different social and income groups and reduced negative area effects. In addition, this type of housing results in a mix of students from various backgrounds in the local school; attracts and supports a higher level of services; and allows a broader range of household composition in one neighbourhood. It also creates additional employment opportunities by increasing the disposable income in the area.

The CSIR is developing multidisciplinary skills and capacity related to the development and implementation of medium-density mixed housing, with a focus on the challenges presented by the South African context.

Medium-density mixed developments have been identified in the New Comprehensive Plan for the Creation of Sustainable Human Settlements (2004) of the Department of Housing (DoH), commonly referred to as Breaking New Ground, as being crucial in efforts to change the nature of South African cities and contribute to the creation of sustainable human settlements. This would include addressing the following objectives: spatial restructuring and integration; optimising existing infrastructure; minimising relocations in the context of informal settlement upgrading; and the

diversification of housing delivery and tenure options.

These objectives are also in line with the Millennium Development Goals adopted by the United Nations in 2000 that set out broad goals related to poverty reduction and environmental sustainability. The DoH is focusing mainly on goals dealing with the development of sustainable human settlements.

International and local studies indicate that a number of factors influence people's perceptions and preferences of a specific type of housing in positive or negative ways, and that these perceptions are very context specific.

The CSIR has embarked on a multi-year research project to determine to what extent medium-density mixed housing developments in South Africa could contribute to achieving greater inclusivity through densification and integration, as prompted in the Breaking New Ground document. The first phase of the CSIR research indicates that it is not clear to what extent these types of housing developments would be viable, stable, secure and sufficiently acceptable for a range of potential stakeholders in South Africa.

South Africa generally has a culture of low-density housing development and many people prefer living in a detached



The CSIR is developing multidisciplinary skills and capacity related to the development and implementation of medium-density mixed housing, with a focus on the challenges presented by the South African context.

Dr Karina Landman

house with access to a garden around the house. Secondly, different income groups have traditionally been separated into various neighbourhoods or housing developments specifically catering for a particular group. It is also not clear to what extent people would tolerate and accept social and spatial mix within one housing development and what type of design would be required to accommodate different age or cultural groups. High levels of insecurity are also prevalent in South African cities, relating to levels of crime, property prices and the factors that influence these, as well as the influence of different groups on social behaviour in general. Insecurity could therefore be a significant factor influencing the potential success of medium-density mixed developments in this country.

The initial phase of the CSIR project indicates that a number of critical factors need to be in place to ensure the success

of medium-density mixed housing developments, and that these factors are closely dependent on the existence of a supporting enabling environment. These elements play a critical role in ensuring the establishment of more sustainable settlements. Research has shown, however, that South Africa poses a number of context-specific realities and challenges. This implies that international ideas cannot just be copied locally without modification and that one cannot assume that specific types of developments would require the same response.

South Africa has a relatively well-established housing research capacity, yet many questions regarding the development of medium-density mixed housing remain unanswered. The current CSIR study therefore has three objectives. Firstly, to determine key factors for the successful development

of medium-density mixed housing developments in South Africa with respect to affordability and sound investment, neighbourliness, safety and security, and the design and lay-out of these developments from the viewpoints of residents, local authorities and developers. The second objective is to establish whether these requirements for success could be met in the South African context, and if so, how to support this through the creation of an enabling environment. Finally, the study aims to assess the contribution of medium-density mixed housing to sustainable human settlements and contribute to the development of suitable approaches and design guidelines to achieve this in South Africa.

Enquiries:

Dr Karina Landman

email klandman@csir.co.za



Planning better cities

Research tools for improved service delivery in urban systems

MORE PEOPLE ARE LIVING in cities than in rural areas for the first time ever, with the United Nations estimating that 60% of the world's population will be living in cities by 2030. Planning and creating sustainable, effective and inclusive cities have therefore become a universal challenge. A CSIR initiative – the urban dynamics laboratory (UDL) – is set to provide the equipment, tools and science environment required to support the development of South Africa's cities.

Enhanced service delivery is a key requirement for government to meet its core social and economic objectives of halving the country's rates of poverty and unemployment by 2014. The UDL provides support for this process by working towards an improved understanding of the dynamics of urban and regional social-ecological systems.

The CSIR will contribute R9 million towards the programme, over a period of three years, while collaborative research partners, including the Department of Science and Technology, are expected to invest up

to R8 million over the same period. Cities – as the engines of national growth, competitiveness and global connectivity – face many complex issues, including competing in the global economy, providing and maintaining high-quality services to millions of people amidst huge urban poverty, high levels of crime and high levels of environmental degradation.

According to CSIR project leader Dr Louis Waldeck, improved spatial planning, based on a thorough understanding of development dynamics and backed by credible, comparable information, can significantly enhance the ability of government to meet the challenges of providing appropriate infrastructure and services.

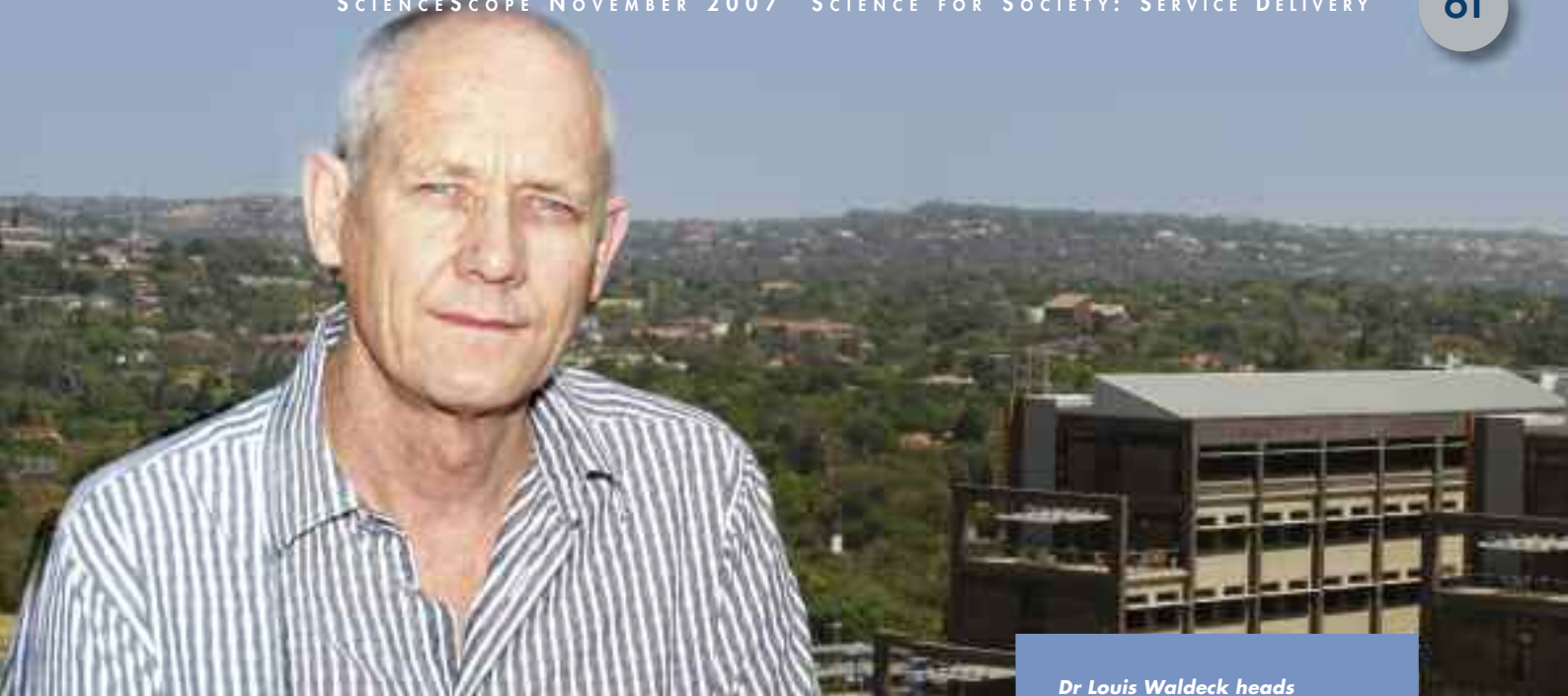
"One of the most difficult aspects of urban research is to find the experimental space within which theories can be tested and 'what-if' scenarios played out to assess and debate the likely effect of behaviours and decisions on development trajectories," Waldeck says. Advances in geomatics, computer-based 3D modelling and micro-simulation of the demographic,

social, economic and spatial dynamics of settlements, are now enabling the development of such experimental spaces.

"The overall objective of the new laboratory is to bring together a transdisciplinary, cross-institutional team and a package of tools and methodologies in a numerical modelling and simulation capability that looks at cities, regions and the development trajectories of these as complex, adaptive socio-ecological systems," Waldeck explains.

The laboratory is envisaged as a workbench to support research that will lead to a better understanding of the dynamics of urban and regional socio-ecological systems in order to:

- Assess the possible impacts of existing and emergent 'drivers' such as changing demographic patterns, crime, insecurity, increasing ambient intelligence, resource consumption or climate change, on the resilience of the system
- Map the flows and balances of resources in the system to understand how changes in the system or different



Cities – as the engines of national growth, competitiveness and global connectivity – face many complex issues.

Dr Louis Waldeck heads the CSIR's urban dynamics laboratory, an initiative aimed at developing research tools to support the provision of appropriate infrastructure and services in South Africa's cities

developmental pathways will affect these flows, and what the effect of these changes in flow will be on the system. Being able to map these will help decision-makers to choose the optimum development pathway

- Identify those points in the system where a small change or action can cause the system to undergo major changes, even jumping to a different state. Knowing where these points are and how to best leverage these, can prevent decisions that would lead to eventual systems collapse, or be used to kick-start positive system change at a place where the multiplier effect of feedback loops will provide the most momentum.

"The facility will be used both as a vehicle for developing, refining and validating numerical models and software, and as a practical workbench that can be used for a wide range of research applications, from testing theories developed in urban sustainability science, to providing science-based decision support in urban planning and design to all tiers of government,"

Waldeck points out. It will include a range of data sets, tools for modelling and simulation of systems interactions and spatial changes, and the necessary hardware to support these tools.

While a significant amount of work has been done on modelling land-use, transportation and environmental change, the UDL will attempt to model social and ecological systems (with temporal and spatial dimensions) while simultaneously grounding the work in whole-systems thinking, complexity theory and sustainability science.

One of the key outcomes envisaged for the research programme is advanced strategic spatial planning systems, methodologies and frameworks, with a specific focus on decision support for infrastructure investment. Also envisaged is the generation of information and data on spatial forms and arrangements that are more conducive to the achievement of national objectives such as democratic nation-building, and social and economic inclusion.

– Deidre Lotter

Enquiries:

Dr Louis Waldeck
email lwaldeck@csir.co.za



Hybrid mini-grid energy systems at Lucingweni on the Wild Coast

In pursuit of energy to stimulate rural economic activity

ACCESS TO ENERGY SERVICES plays a major role in economic development, yet the linkages between the provision of energy and poverty alleviation through economic development are not fully understood. This lack of understanding contributes to the relatively slow pace of energisation of the African continent. Rural energy for economic development (REED), a long-term research project by the CSIR, is working towards improved understanding of these linkages by investigating interventions to increase economic development in underdeveloped communities through energy provision and processing, value addition to natural or renewable resources, and the efficient use of energy.

Africa's economic priorities are strongly informed by the need to alleviate poverty. With more than 500 million people currently without access to electricity, and more than 600 million people on the continent dependent on traditional biomass for survival, Africa has a dire need for safe,

affordable and clean forms of energy in order to allow productive economic activities that are able to generate much needed income. Systems and processes aimed at providing energy must, however, also take cognisance of Africa's other primary needs, such as delivering potable water, sanitation, improved access to markets, communications, transport infrastructure and health services.

"The delivery of new energy services must be based on a systemic and holistic approach where Africa's primary needs and poverty reduction are included in any paradigm for development," says CSIR project leader Steve Szewczuk. "The challenge of alleviating poverty through establishing new economic activities must be taken up; validated decision-support processes can be used to assist in this effort. However, the implementation of such processes and technologies must be supported by good information and science, technology and innovation."

Szewczuk points out that addressing rural poverty will inevitably entail a broad range of activities, including the creation of more productive, higher-paying employment opportunities alongside subsistence agriculture, and developing new, higher value-added exports, based on locally grown or exploited natural and renewable resources. Supply-chain linkages must be established between local, community-based firms and multinational companies. For a region to export value-added goods, needs such as the provision of efficient energy services, adequate health and sanitation services, and efficient logistics must be addressed. The resultant improvement in rural access and development will be particularly beneficial for women and children.

Due to the complex nature of rural socio-economic development, and to achieve the objectives of the project, the CSIR team has divided the REED research programme into four components, namely:

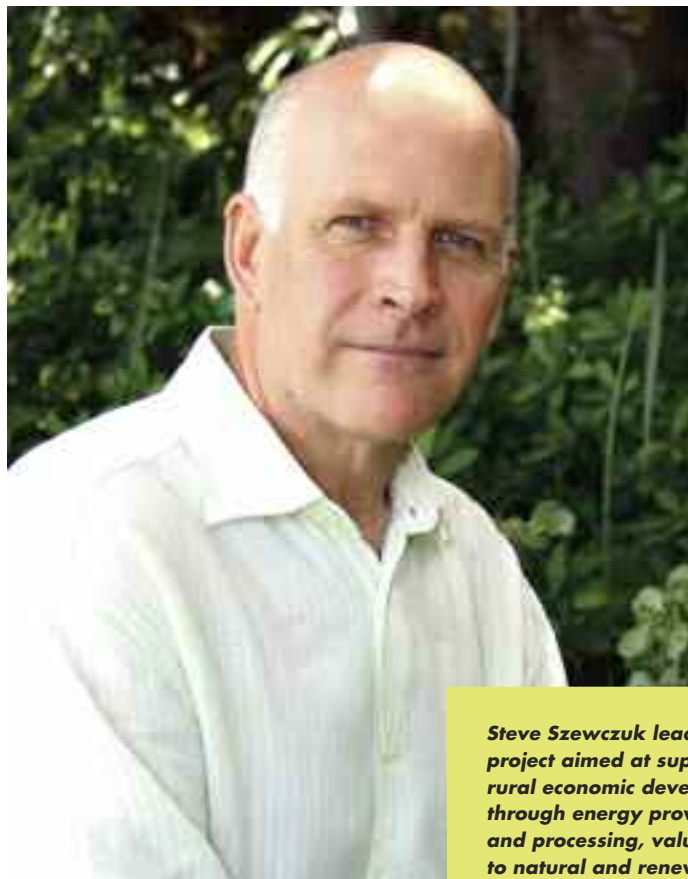
Africa has a dire need for safe, affordable and clean forms of energy in order to allow productive economic activities that are able to generate much needed income.

- Systemic energy-economic methodology
- Green advanced sustainable products
- Energy efficiency and effectiveness
- Rural energy-active laboratory.

"With validated methodologies employing developmental economics, simulation and modelling and geo-spatial analysis, we aim to identify targeted intervention measures that could stimulate and increase economic activities, based on natural or renewable resources," says Szewczuk. "This is expected to result in an increase in the demand for modern forms of energy in underdeveloped communities, while also ensuring the efficient use of energy."

In addition, the team is studying the effect of different development strategies in a community, leading to the formulation of effective business models, to be applied in conjunction with implementation partners.

"We will research, develop and implement technologies, based on market-orientated supply-chain linkages between local firms and multinationals, where high-value natural or renewable resources and materials are value-added through novel processing and



Steve Szewczuk leads a CSIR project aimed at supporting rural economic development through energy provision and processing, value addition to natural and renewable resources, and the efficient use of energy

manufacturing technologies," explains Szewczuk. Examples include biobased materials obtained from the agriforestry sector and novel, natural ('green') composite materials for the aerospace sector.

To complement available energy generation technology options, the CSIR plans to develop and implement novel technologies that will ensure the efficient use of energy, particularly since the provision of energy has capital, operating, maintenance and tariff costs associated with it – cost components that influence the financial viability of potential projects. Detailed investigations are planned for solar thermal-related technologies, gas turbine-based systems and wind energy systems for low wind-speed conditions. The team also studies technologies related to the conversion of domestic wastewater into energy.

"It is estimated that more than 40 000 South Africans die every year from diarrheal diseases due to inadequate sanitation and water-borne diseases. If domestic wastewater can be used partly as a resource to be converted into energy, such conversion technologies will not only provide energy and electricity, but can also contribute towards improved quality of life through a reduction in water-related diseases," says Szewczuk.

The methodologies will be validated through a rural energy-active laboratory. A 'rural living lab' approach will be followed, where the current situation can be properly mapped, researched and documented and where a suite of researched interventions can be followed over time. These can then be monitored, evaluated, documented and used for providing feedback to any rural socio-economic developmental model that is developed.

In addition to undertaking research into methodologies and technologies planned to alleviate poverty and contributing towards meeting the Millennium Development Goals, the REED project will also help alleviate climate change concerns by generating various mitigation and adaptation options. *– Deidre Lotter*

Enquiries:

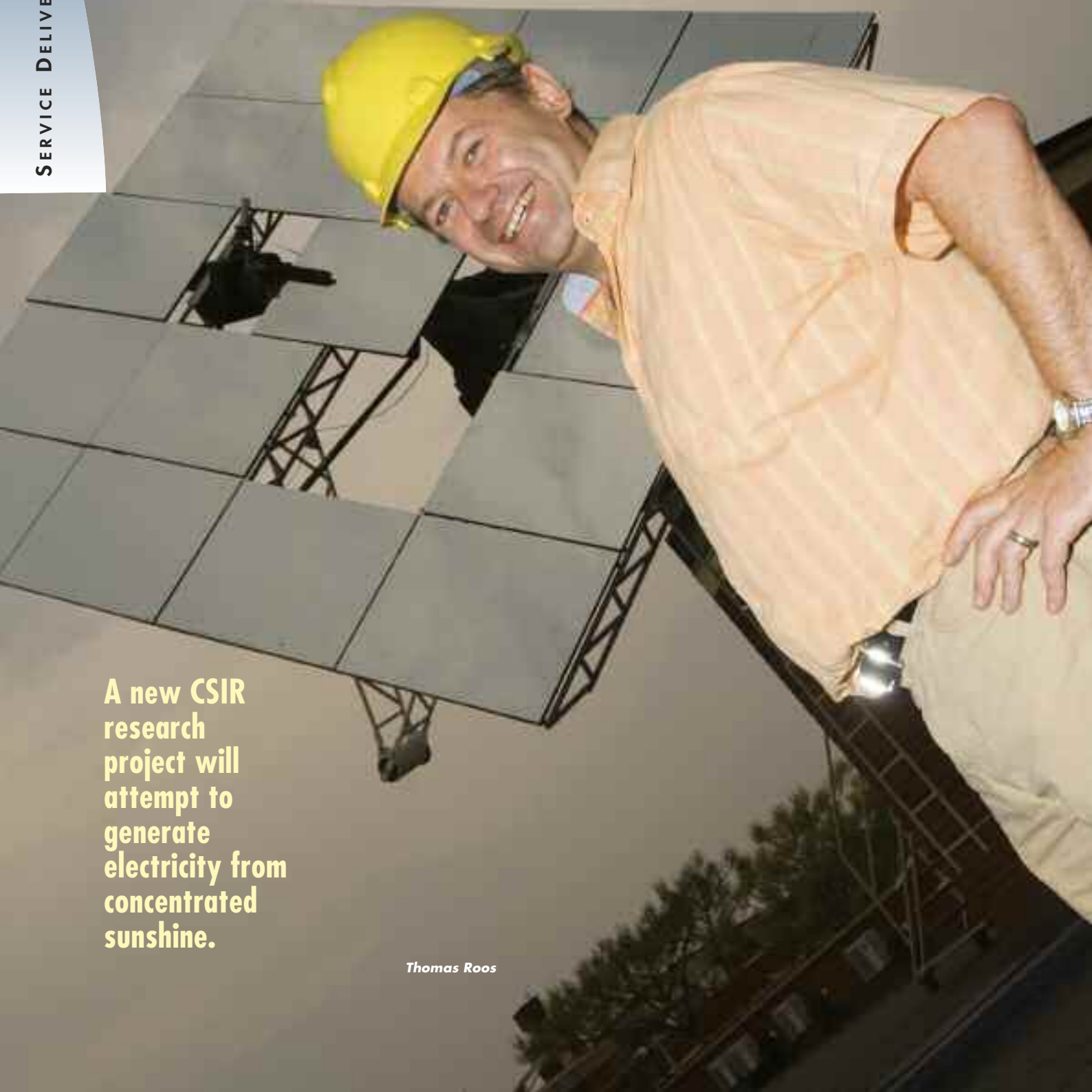
Steve Szewczuk
email sszewczuk@csir.co.za

Enabling access to electricity for all through sun power

SERVICE DELIVERY

**A new CSIR
research
project will
attempt to
generate
electricity from
concentrated
sunshine.**

Thomas Roos



UNIVERSAL ACCESS to electricity is a priority for the South African government. In his State of the Nation address, President Thabo Mbeki announced the target of universal access to electricity for all South Africans by 2012. Currently, there is a backlog of 3,4 million households in South Africa without access.

Many villages still not connected to the national electricity grid are small and far from the grid. According to the CSIR's concentrated solar thermal power expert, Thomas Roos, the significant expense of extending the grid to small, remote villages cannot be justified by the few new subscribers connected. For these villages, distributed generation makes more economic sense. This view is supported by a statement by the Minister for Minerals and Energy, Ms Buyelwa Sonjica, who at the French-South African conference on energy in Cape Town earlier this year, said: "A challenge to the Department of Minerals and Energy is the integration of alternative energy carriers into rural electrification, where there is little or no bulk infrastructure. In some areas the topography is such that it is difficult to get even the same bulk infrastructure to those areas."

The CSIR has been involved in research activities to address this need for electricity in communities not connected to the national grid for many years, with researchers looking at creating local independent 'mini-grids'. These are powered by renewable energy systems – typically photovoltaic (PV) cell arrays and wind turbines. Unfortunately, the resultant electricity

is much more expensive than that from the coal-based grid. The renewable energy sources available (sun and wind) are intermittent, requiring battery storage and diesel genset back-up, increasing costs and complexity. Furthermore, liquid fuel costs for the diesel gensets are high, and the PV arrays are not cheap.

A new CSIR research project will attempt to solve this problem by generating electricity from concentrated sunshine. Solar thermal technologies, which drive heat engines using concentrated solar power, are the basis of several new solar power stations in Spain and the USA, and are much cheaper per kilowatt-hour than photovoltaic systems, says Roos.

In 2005, the EU Framework 6 project, ECOSTAR, published a comparison of experiences with seven different such solar thermal technologies: Two trough systems and three central receiver systems (all steam cycles), a Dish-Stirling and a solar gas turbine. Of the seven technologies, the solar gas turbine gave the lowest levelised electricity costs (LEC) by 10-28% in solar-only operation and by 47-58% in hybrid operation with fossil fuel. Gas turbines operate at temperatures above 1 100 K, so this technology requires higher solar concentration ratios than steam turbine systems, which operate below 900 K. In water-stressed South Africa, solar gas turbines have the added advantage that they do not require cooling water, unlike solar steam-based systems.

It is therefore believed that an ideal solution to the remote rural power question would be a solar gas turbine system running on concentrated solar energy when available, and stored solar thermal heat or fossil fuel during cloud cover or night-time. This avoids the use of multiple systems in parallel (wind turbines, PV and diesel gensets), and still guarantees power. Of the available renewable energy resources (solar, wind, biomass, micro-hydro, geothermal, ocean wave and current), only solar energy is available in good to excellent quantities, everywhere in South Africa.

In a solar gas turbine system, a heliostat field concentrates solar radiation to the top of a tower, where it is further concentrated in secondary concentrators. This concentrated heat is absorbed in volumetric receivers by high-pressure air from the gas turbine compressor. The solar heat reduces or even replaces the liquid or gas fuel burnt in the gas turbine combustor.

A 25 m² target-aligned heliostat has been developed at the CSIR, using low-cost components and simple systems. This is the first part of a hybrid solar/fossil fuel gas turbine distributed power research programme with the goal of supplying appropriate technology for electricity supply to off-grid South African and African communities. – *Mzimasi Gukumana*

Enquiries:

Thomas Roos
email throos@csir.co.za





Long-range 'Bokkie' routers used in the mesh network

Wireless networks: Connecting Africa's 450 million people

"The magic's in the antenna. Instead of a single omni-directional antenna, we may use several focused antennas (like cans) within a box. By squeezing the radio waves into another shape, we hope to ensure that the network can seek its next connection more efficiently."



Kobus Roux, who heads the wireless Africa project

WHAT DOES THE remote community of Peebles Valley in Mpumalanga, South Africa, have in common with rural communities in Zambia? Both have experienced the benefits of low-cost wireless mesh networks – the outcome of research done in this domain at the Meraka Institute, a national research centre managed by the CSIR.

Mesh networking is a method by which incremental connectivity is achieved through adding wireless mesh nodes to existing hotspots, which then relay the signal to extend the coverage. The network can be expanded by the community. By nature of its novel qualities, the wireless network configures itself (should additional nodes be added) and heals itself (should a node be removed).

In itself, the technology that underpins wireless mesh networking could be seen as little more than an interesting experiment, albeit at a large scale. Its real value, however, lies in the fact that connectivity achieved through wireless networks is a highly effective way to empower communities with communications and access to information, thereby achieving sustainable socio-economic benefits.

With a successful track record in wireless connectivity, the Meraka Institute team took a long, hard look at the challenges facing developing countries. Comments Kobus Roux, "We asked ourselves, 'Where can we contribute best?' We knew the answer, so it became clear that we needed to use this expertise to undertake long-term research that will allow us to make a difference in the quality of people's lives."

Off-the-shelf WiFi components used to build low-cost intelligent mesh nodes

The wireless Africa project espouses ambitious goals. Roux says, "Our target is to contribute significantly to connecting Africa's 450 million people who currently do not have access to any form of connectivity."

Peebles Valley: Proof of concept

In 2005 the Meraka Institute helped establish a mesh network in Peebles Valley. Out of this project came the now famous 'cantenna', comprising a metal can, such as a coffee tin, and a section of bicycle spoke soldered into a special connector that can connect to another point with a similar antenna up to 5 km away.

These small, self-constructed antennas, which are made from locally available material, are connected to a low-cost WiFi card plugged into a computer or small wireless router placed in a weather-proof casing on a pole to which several community members can connect and form a community mesh network. This mesh networking technology allows the wireless installations to configure themselves automatically to find the optimal routes through the network. This technology has also enabled the local high school to gain internet access through its computer centre.

"This was our first community wireless network experiment," says Roux. The group used existing technology and followed a hands-on approach in assisting the community. As such, Peebles Valley proved an important springboard for the group to consider further opportunities for wireless mesh networking.

LinkNet: The Zambian 'connection'

The signing of a memorandum of understanding (MoU) between LinkNet Multi-Purpose Co-operative Society Limited of Zambia and the Meraka Institute in August 2007 marked the next significant step towards low-cost, wireless connectivity in Africa. The MoU followed from a hands-on training workshop with LinkNet hosted at the Meraka Institute to share knowledge on the planning and deployment of a wireless mesh network. The institute released a do-it-yourself mesh guide providing step-by-step instructions to assist the LinkNet team.

Roux explains, "We started to establish wireless mesh networks in South Africa. Now we have the opportunity to expand our research further into Africa." He is excited that the Peebles Valley model can be tested and enhanced from Zambia.

Connecting Africa

To achieve the vision of ubiquitous connectivity by 2017, Wireless Africa does directed research in long-distance, energy-efficient mesh networks for rural applications. It goes without saying that the group faces various challenges in this regard.

Energy remains one of the most critical constraints in the project. Advances in solar energy technology is required for the communications network. By combining the network communications protocol and the antenna technology, it is possible to enhance the efficiency and reach of the network. "The magic's in the antenna," says Roux. "Instead of a single omni-directional antenna, we may use several focused antennas (like cans) within a box. By squeezing the radio waves into another shape, we hope to ensure that the network can seek its next connection more efficiently."

Shaping and informing the nature of the wireless Africa research agenda is the awareness that technology solutions should match the cultural milieu in which these will be implemented. Low cost remains an essential requirement. "Ultimately we would like to see a community-driven model for sustainability," Roux concludes.

– Biffy van Rooyen

Enquiries:

Kobus Roux
email kroux@csir.co.za



Franchising to improve delivery of water services



Dr Kevin Wall

Resources allocated to a water services franchising programme would be well spent in terms of creating sustainable jobs and enterprises, in addition to the water services delivery that would ensue.

WATER SERVICES FRANCHISING

has the potential to improve the efficiency of water services delivery in South Africa. This finding of a study initiated by the Water Research Commission (WRC) in 2005, led to a follow-up project by the CSIR and the WRC aimed at identifying those elements in the water services delivery chain that offer the greatest scope for franchising, and developing franchising models.

The rapid rate of construction and commissioning of new water services infrastructure in the past decade is severely challenging municipal institutions charged with operating and managing this infrastructure. "Alternative options for water services operation and maintenance should be explored and innovations should be incubated – including public sector-driven partnerships with non-governmental and community-based organisations – selectively, on an experimental basis," says the CSIR's Dr Kevin Wall, who led the 2005 study and manages the current project.

"Our first study indicated that more than 400 franchised systems are operating through some 26 000 franchised outlets nationally, generating retail sales of approximately R200 billion annually," says Wall. A review of local economic develop-

ment in South Africa formed part of the first study and concluded that there is an immense need for the creation and nurturing of small and micro-enterprises, thus providing a strong additional reason to investigate franchising as a water services provider model.

While franchising is not suitable for investment in new water services infrastructure, it can be applied to facilitate ongoing operation and maintenance. "Franchising is a way of accelerating the development of a business, based on tried and tested methodology," explains Jay Bhagwan of the WRC. "Franchisee water service providers, dependent for their livelihood on the success of their business, would have a strong incentive to perform and would also enjoy the benefit of the franchisor's expert guidance and quality assurance. A franchisor can ensure a professional approach, quality control and ongoing training, as well as advice and assistance when needed."

Wall agrees, pointing out that assistance from the franchisor would be of particular value in municipalities located some distance away from major urban centres. "Few of these municipalities can afford to employ competent, qualified staff; significant improvements would soon be seen if

they could tap into the ongoing support, mentoring and quality control that a franchisor would provide, or if the municipality could enter into public-private partnerships with access to the necessary support."

The key objectives of the current study are to identify elements in the water services delivery chain that offer the greatest scope for franchising, and to develop franchising models for these areas, taking into account legal, regulatory, financial, technological and other relevant aspects. This will be followed by the development of guidelines for embarking on water services franchising.

Resources allocated to a water services franchising programme would be well spent in terms of creating sustainable jobs and enterprises, in addition to the water services delivery that would ensue. Says Wall, "Some 400 000 people are employed in the franchising sector, a good indication of the sector's ability to create jobs. Much evidence exists that, everything else being equal, franchised businesses have a far lower failure rate than independent businesses."

– Deidre Lotter

Enquiries:

Dr Kevin Wall
email kwall@csir.co.za

THE CSIR'S OPERATING UNITS, NATIONAL RESEARCH CENTRES AND SERVICES

■ CSIR Biosciences

Pretoria 012 841-3260
Modderfontein 011 605-2544

■ CSIR Built Environment

Pretoria 012 841-3871
Stellenbosch 021 888-2508

■ CSIR Defence, Peace, Safety and Security

Pretoria 012 841-2780

■ CSIR Materials Science and Manufacturing

Pretoria 012 841-4392
Johannesburg 011 482-1300
Port Elizabeth 041 508-3200
Cape Town 021 685-4329

■ CSIR Natural Resources and the Environment

Pretoria 012 841-4005
Johannesburg 011 358-0000
Stellenbosch 021 888-2400
Durban 031 242-2300
Pietermaritzburg 033 260-5446
Nelspruit 013 759-8036

■ CSIR Knowledge Services

Pretoria 012 841-2525
Stellenbosch 021 658-2766
Cottesloe 011 482-1300
Modderfontein 011 605-2452

■ Meraka Institute

Pretoria 012 841-3028
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Cape Town (Centre for High Performance Computing) 021 658-2740

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Hartebeesthoek 012 334-5000

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Enquiries: (012) 841-2000 query@csir.co.za

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