Defence and security on land

Landward operations are typified by a human-centric focus that has to show responsiveness and sensitivity towards the national imperative, the needs of societies, communities and individuals. This encompasses components such as rule of law, education, culture, health, diplomacy, governance, history and commercial interests. With a duty such as this, the South African Landward forces are no longer just a military component of the South African National Defence Force but an instrument of socio-economic development in the country, the region and the larger African continent.

The decline of conventional war and the exponential increase in operations-other-than-war (OOTW) (i.e. peace enforcement, peace keeping, stabilisations, reconstruction, and civil or community support) bears testament to the migration from state security to human security. This ne cessitates a corresponding increase in feet on the ground, greater responsiveness, undertaking of expeditionary operations into the region, and skills in the 'softer' social sciences (for example, conflict resolution) that complement the 'hard' technologies that provide the lethal strike capability. Great opportunity exists for close cooperation with foreign national forces, and unprecedented levels of civil-military cooperation (CIMIC) involving other government departments, foreign and local agencies, and the local civilian population.

The complex realities of the landward operational threat environment include female and child soldiers, formal military forces, rebels, private security agencies, the occurrence of atrocities, genocide, terrorism, asymmetric warfare, famine, water scarcity, the scramble for precious minerals and resources, frustration and violence especially amongst the youth, refugees, illegal immigrants, natural and manmade disasters, civil disobedience, extremism, passive resistance, use of Improvised Explosive Devices (IED) to name a few. It is clear that our Landward Forces face an entirely new war. A war that requires combat on the one hand – plus peace keeping and enforcement on the other. Yet, while the battle space has expanded considerably, resources – both human and financial – have not increased accordingly.

The key figure remains the soldier. A solder that is well educated and trained in the realities of the task, fit and healthy, skilled, disciplined and professional. Not only does this figure contribute to the power of the force, but also serves as a role model of competent leadership in civil society. Key "hard core" technologies will be required to improve the soldier's situational awareness: night vision, man-portable drones, unattended ground sensors, data mining of other battlefield sensors like UAVs, communications (including smart phones), lethality that includes less-than-lethal means; the ability to call for fire support and designate targets to precision munitions; survivability through improved personal protection, IED detection, and battlefield medical support; sustainability through better rations, hydration and power supplies, mobility and load reduction.

The increasing availability of these technologies as commercial-off-the-shelf (COTS) can be exploited by the military. However, the challenge would be to adapt and integrate these 'commoditised' technologies to be fit for purpose, practical and effective. Ultimately, science, engineering, and technology support is required to achieve the required balance between high-tech and low-tech solutions and combinations thereof in a financially-constrained environment.

In terms of steering strategy, a threat-based planning approach which subscribes to the notion "to be the best at peacekeeping, you need to be the best at war fighting" is misplaced. The skills sets required for peace support operations are vastly different than those needed for war fighting. It would be prudent to adopt a capability-focused planning approach instead which is a scenario-based, and a concept-led process supported by trade-offs and joint experimentation, force employment at operational level where joint and inter-agency forces can integrate. This focus will also bring to the fore the role of intelligence that allows for preventing threats from developing.

"A Defense Force can, thus, be an important agent of national development, which has been and continues to be demonstrated in several countries".

Defence Review Draft Consultative Report , 2012

The CSIR supports the approach of first understanding a problem or need through scenario development and analysis, working to develop the solution with operational concepts, architecture (processes, organisational and technical systems), effectiveness analysis and trade-off studies, as well as supporting implementation. The value of this approach lies in reduced risk through increased integration, more efficient, longer-lasting solutions due to more stringent consideration of options, and innovation in security and operating concepts at an inter-departmental level, plus architecture at a departmental level. An example of such work is the CSIR's support to Joint Operations on a 'whole-of-government' approach to Border Safeguarding.

The complexity and dynamism of the future "battle space" will require a dynamic and responsive Landward Force. To this end, the future Landward Force requires science, engineering, and technology support to ensure smart strategy, smart operations, and a rightful place as a smart user and buyer. In short, have the power base to operate as a smart force.

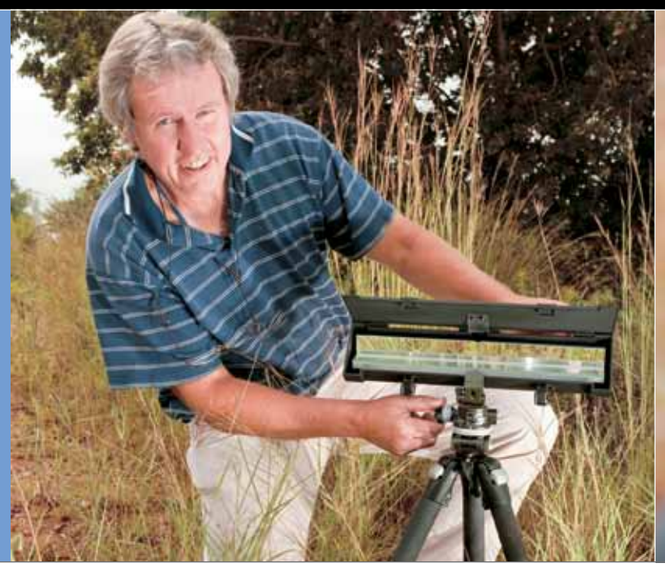
DEFENCE AND SECURITY ON LAND

The science behind camouflage

Camouflage relies on colours, patterns and textures that closely match those in the environment. Psychophysics – understanding how humans see the environment – is critical to developing an effective camouflage pattern. It is also the most complex of all psychophysical aspects of human vision.

For well over 15 years, the South African National Defence Force (SANDF) has used a camouflage pattern designed by CSIR researcher Arnold Jones (now retired).

The CSIR's camouflage expertise puts it at the forefront of pattern design for mission-specific objectives and to keep our armed forces well-hidden and protected.



Camouflage 'on demand' to meet mission needs

"The ultimate in camouflage is wide-band, adaptive camouflage. Nanotechnology will influence camouflage technology significantly in the future."

The challenge to conceal and protect our armed forces is well met by the extensive research experience of the CSIR's camouflage specialists.

Johannes Baumbach is a senior researcher at the CSIR with vast experience in camouflage research who regularly assists the SANDF with their camouflage needs and requirements. Together with fellow researcher, Bernardt Duvenage, they developed a computerised camouflage simulation tool that aids in the evaluation of mission-specific camouflage designs. Funded by the Department of Defence, the simulator evaluates camouflage patterns on-screen to rapidly and cost-effectively evaluate a proposed pattern for a specific terrain.

Cost and colour are critical in effective camouflage design and manufacture. Most of South Africa's textile printing takes place in climatically uncontrolled environments where humidity and temperature affect the colour consistency in garments. Colour calibration to match on-screen and environmental colours is essential, as well as consistency in the manufacturing process to improve the effectiveness of camouflage in use. Only top-performing designs are manufactured for field evaluation. Some nations have cut back on the number of camouflage designs in use because of the logistics and costs.

Camouflage research has led to a concept personal net for the soldier, developed by Baumbach and Dave Roos, a researcher in the Landward Sciences domain. This net will improve the effectiveness of operations and the comfort of the soldier during border protection missions. Over and above camouflage and improved observation of the environment, it provides shade, protection against mosquitoes and insects, as well as protection against wild animals.

The future of camouflage lies in wide-band, adaptive camouflage that is effective in the visible (day-time), near infra-red (night time), thermal and radar bands, as well as new terrahertz imaging technology. On-demand camouflage is the way for the future: changing the properties of the camouflage system at will, to suit the mission, environment and threat. Nanotechnology now makes it possible to change the properties of materials, which will influence camouflage technology significantly in the future.

The CSIR's camouflage research team is determined to stay abreast of the latest developments in this field to contribute to the safety of those mandated to protect us.

Mortars for modern conflict situations

A novel mortar set-up method developed by the CSIR can be critical in modern conflict situations. According to CSIR principal engineer Danie de Villiers, in modern warfare, mortars need lighter, more responsive and lethal systems. The use of prismatic mirrors resolved these issues. The CSIR assisted the SANDF artillery who initially replaced the mortar's aiming post with a prismatic mirror similar to those used in the Ratel armed vehicle attack vehicle to improve the effectiveness of the aiming post.

Traditionally aimed with a compass, two aiming posts and a mechanical sight, this new system uses a prismatic mirror and alternative set-up procedure. The mirror bearing is tracked and provides a bigger arc of fire with no parallel problems, unlike the previous system where the mirror was fixed and used as a reference while positioned in the arc of fire. Benefits of the new system include no change to current mortar sights, a quick set-up procedure and improved reaction speed in engaging opportunity targets. Without a detectable thermal image, it can be used at night. Also, with an accurate mirror set-up comes greater first-hit probability making the system more cost-effective.

The concept has additional advantages: Full digitisation is possible with a GPS compass, tilt sensor for the mortar pipe and shaft encoder to track the bearing, while solders can pack it up quickly to move to new position.

A sense of connectedness: Haptic technology in situation awareness

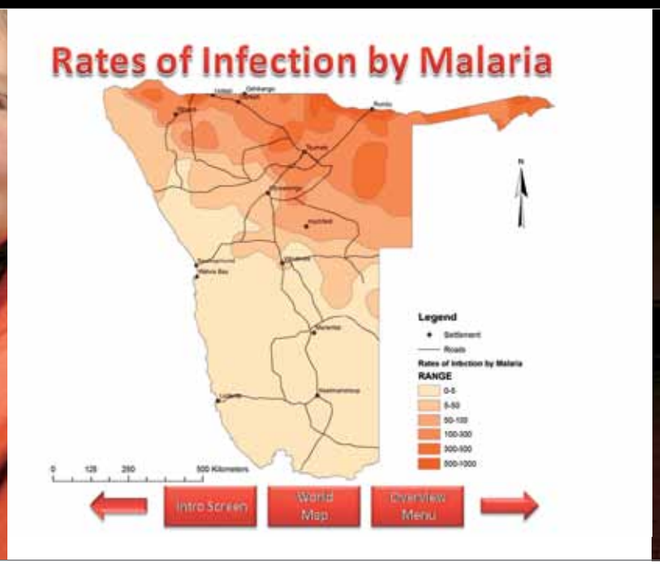
"A combination of haptic technology and a communication device keeps the solider on track and in touch."

Research and tests across a spectrum of digital technology by the CSIR's Stefan Kersop contributes to a soldier's full situation awareness capability. Haptic (i.e. sense of touch) technology is the key. Vibrating sensors placed on a soldier's body will guide direction to the left or right depending on which side of the body the sensors are vibrating.

Added to the vibrating sensors to guide movement, a CSIR-developed communication device keeps soldiers in touch with their team members and commander. The small device connects to a radio from where information can be transmitted over the network. A solider can identify his or her position and send a short message, similar to a sms on a mobile phone.

The device has been laboratory and field-tested to assess water, heat and corrosion resistance and to ensure that it works in rural areas and near tall buildings. Soldiers are involved in the evaluation of the device together with researchers from the CSIR, providing the feedback necessary to further improve the design and functionality.

DEFENCE AND SECURITY ON LAND



Geospatial atlas of disease intelligence and countermeasures

"The medical atlas will help medics identify risks and conditions in their areas of responsibility and keep soldiers fit to fight."

The CSIR is using geographic information systems (GIS) to create medical atlas software for the South African Military Health Services (SAMHS).

Unlike their civilian counterparts, military healthcare providers must be ready to deploy people and services at a moment's notice, whether into conflict situations or to provide humanitarian or peacekeeping assistance.

With the Geospatial Atlas of Disease Intelligence and Countermeasures, regional information ranging from weather conditions to medical facilities is easily accessed by military medics, troops and intelligence personnel. According to military geospatial analyst Minette Lubbe, formerly a lieutenant colonel in the SA Defence Force, the GIS data provide medics with environmental health, disease and climate information when planning deployment. This helps decisions about what clothing and medical equipment is needed.

Troops and medics can prepare optimally with information about topography, population, water supply, living and sanitary conditions, prevalent diseases and medical facilities, pollution and threats from animals and plants in areas of deployment. For instance, anticipating deployment in an area known for poisonous snakes but no poison centres, means including anti-venom kits need to be added to the supplies.

The atlas can also be used in emergency situations, such as overlaying maps with topographical data, clear-cut areas, transmission lines and soil type to determine the most suitable landing zone for a helicopter in an evacuation or rescue situation.

Although developed for military use, the atlas is useful to all medical professionals and civilians who do field work in Africa. The atlas continues to grow as more data is collected to build country profiles. The goal is to create a unique source of information for a vast range of user-specific queries.

Medical geography combines geographic factors with studies of health and disease and the impact of climate and location on health. Malaria, for instance, is more prevalent among people who live at low elevations near waterways than those living at higher elevations.

Lighting for safer landing

The Special Operations capability of the SA Defence Force enlists a particular brand of soldier, to operate under particularly difficult circumstances. These operatives most often require technology solutions of particular sophistication and precision.

Chris Botha is a project manager and technician at the CSIR's section for Technology for Special Operations. Together with his team, he designed and developed a product named CANDLE, a portable landing light system which won them international acclaim.

The system is lightweight and can be carried as part of a paratrooper's kit. It is rapidly set up to either mark a drop zone for paratroopers or to lay out a landing strip for aircraft with infrared or normal visible light. Great novelty lies in the fact that the lights are remote-controlled and can be switched on and off either by operators on the ground or the pilot from as far away as ten kilometres.

CANDLE is most often used by paratroopers in peacekeeping operations, who perform a pathfinding function, and who are dropped in areas where there is no landing strip.

The system consists of twelve lights, each fitted with a transmitter/receiver with a remote control effective up to 600 metres/10 km (long range) and 200 metres between lights. With six lights on either side, a landing strip of 1 000 metres and longer can be marked out. This means a plane of the size of a Hercules transport aircraft can be guided with this system.

When the aircraft approaches, the lights are switched on, and then switched off immediately once it has landed safely. Because it is infrared enabled, the lights are only detected by night vision equipment and thus remain unseen by others with the naked eye.

Initially required to assist defence force personnel in areas without sufficient air transport infrastructure, the system has also found civilian application among mining companies both in South Africa and further on the continent. It was awarded a coveted International Soldier Technology Award in 2006, selected from amongst a number of soldier modernisation programmes from around the world.

The CSIR is currently upgrading the landing light product to include landward-based sensors that serve as an early warning system for protection as well as a detection capability for intrusion into secure environments. Finalised products will be made available for industrialisation under a licensing agreement.

DEFENCE AND SECURITY ON LAND

A lighter load for soldiers

Soldiers are often required to carry more than 80 kg on their backs while still expected to operate optimally, especially in hostile environments. A backpack usually contains water, ammunition, batteries and equipment such as a radio and GPS. Most of the equipment that a soldier carries uses batteries, which alone can contribute about 20 kg to a backpack. Achmed Giesler and Inus Grobler, researchers in the CSIR's Technology for Special Operations group, are developing ways to lighten this load. Involved in a number of projects that address power generation and management, they have research the use of salt water batteries, fuel cells and solar panels.

The most viable option in fuel cell technology is the direct methanol fuel cell (DMFC), which converts methanol at low temperature to electric power. The CSIR's researchers were part of a European consortium that supported the company Smart Fuel Cell to develop a fuel cell that soldiers could carry in their backpacks. One of the company's products won the $1 million Defence Advance Research Programme Agency (Darpa) challenge for fuel cells for the dismounted soldier in 2009.

Working with industry, the researchers successfully developed, tested and evaluated a new battery pack system for the SANDF VHF radio (A43) in 2009. The packs are seen as 'intelligent' due to their built-in protection and specialised Coulomb counting that indicates to users the amount of power left in the battery pack. The pack is also lighter with higher capacity and better reliability. Soldiers can now power their entire range of equipment, including laptops and satellite phones, from a single power source.

In addition to stringent tests, the CSIR is consistently customising the power manager unit to ensure that soldiers can perform optimally.

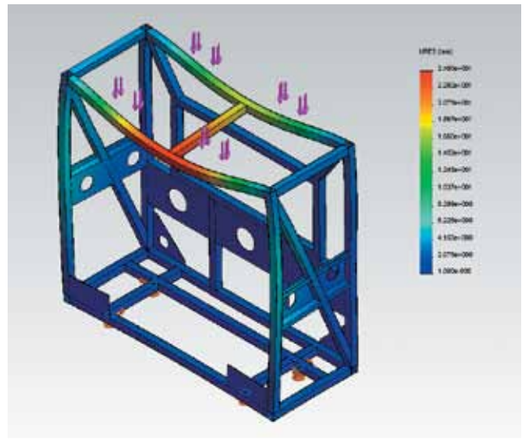
CSIR helps solve mobility challenges for border patrol action

By adding novel capabilities to existing commercial vehicles, the CSIR successfully turned them into robust and effective mobility options for carrying troops, patients, control centres and conduct border patrolling. With even, the ability to, literally, roll over safely if the situation requires. Toughened to perform its official duty, the benefit of these vehicles is that it does not harm ecosensitive areas so often found in border parts.

The South African National Defence Force (SANDF) is tasked with the responsibility of border safeguarding – a role that surfaced a number of operational challenges requiring innovative solutions – that is, protection against dangerous animals; exposure to insects and extreme heat; and vehicles that would be suited to patrols, fast-reaction capabilities, able to carry people, medical support and other loads. To address the mobility requirements, the CSIR was asked to assist in identifying the best-suited family of vehicles that would support effective border patrol.

A stringent process of evaluation led to identifying a commercial vehicle family and the CSIR set about inventing enhancements to further bolster the different vehicles to safely carry troops, medical equipment and patients on stretchers, logistical and command and control systems. The enhancements included special roll-over protection structures – ISO certified and innovated from new composition steels and structural sections and interfaces to comply to load restrictions. The structure also had to be approved by the original equipment manufacturer (OEM) to ensure that normal vehicle warranties remained intact. This development was done in collaboration with the University of Pretoria and a manufacturer that was approved by the OEM – to whom the final engineering datapack was transferred.

The CSIR's work enabled the SANDF to understand the special requirements of the patrolling activity and procure the most robust, cost effective solution – while ensuring safe and strong border protection.



DEFENCE AND SECURITY ON LAND

Expert TEST, MEASUREMENT AND EVALUATION services and facilities

The CSIR offers a range of explosive event test, measurement and evaluation services to research and evaluate engineering designs as well as support and promote landmine, IED and other blast threat protection capabilities for both the SANDF as well as the local military industry.

Test, Measurement and Evaluation of short time duration events is a specialised field due to the high sampling rates required to capture data under field conditions presented by explosive test ranges. CSIR researchers make use of specialised in-house developed and validated equipment and techniques as well as a range of validated surrogate scientific charges to execute experiments, measure the outcome of the experiment and to correlate findings with the theoretical base in this complex research field. Many of these techniques were developed by the CSIR and refined over many years.

Tests are performed at a Detonics, Ballistics and Explosives Laboratory situated near Pretoria in SA's Gauteng province. Testing capabilities range from small arms testing and small scale blast tests of up to 200g and explosive events up to 50kg Net Explosive Content (NEC). A number of shelters ensure the safety of operators in compliance with Health and Safety Regulations and provide protection to test and measurement equipment. The facility is supported by a specialised explosive casting facility that can prepare required scientific test charges to specification.

The CSIR has a wide range of both laboratory and field measurement systems and sensors to support explosive testing, research and validation. This includes a variety of high-speed cameras, multi-head digital flash x-ray, pressure and strain measurement systems.

The CSIR provides an international capability to test and validate mine protected vehicles (MPV) against various landmine and Improvised Explosive Device (IED) threats, to both local and international military standards.

Measurement equipment

- Medium, high-speed and ultra high-speed photographic and video equipment
- X-ray systems (X-ray and Flash X-ray)
- High-speed data acquisition
- Electronics laboratory
- Instrumented impulse measurement apparatus
- Water blasting facility

Research into human vulnerability and response is also supported by in-house developed drop test rig and lower limb impactor devices complimented with latest bio-mechanical measurement surrogates such as the Mil-lx leg, HIII and ESIIre anthropomorphic test devices, etc.

The following test, measurement and evaluation procedures are performed:

- *Landmine validation testing*
- *Vehicle IED protection evaluation in accordance with draft NATO standard*
- *Short Event Measuring Equipment*
  - Scientifically Instrumented Impulse Measurement Apparatus (SIIMA)
  - Flash X-ray
  - Cordin Ultra High Speed Camera
  - Human Response Test Rig (occupant safety systems)
- *Blast Pendulum (Measuring of the Imparted Impulse of Scaled Explosives)*
- *Emily and Semily (Enclosed Blast Chamber for Enhanced Blast Testing)*

DEFENCE AND SECURITY ON LAND

Science in explosion events

The CSIR's measurement methodology is based on evaluating and comparing various explosives and munitions in terms of blast characteristics. The research is used to develop scientific surrogate charges and to analyse and protect against such threats.

The DBEL facility is used by various teams within the CSIR's defence research capability to inform the design, engineering and development as well as independent evaluation of suitable and effective soldier and vehicle safety solutions.

Scientifically recreating the threat enables in-depth analysis leading understanding and development of suitable protection technologies. As an example, a **Rocket-propelled Grenade (RPG) surrogate was developed** that could mimic the operation of a real RPG weapon so that realistic and effective protection solutions can be devised against such weapons. This weapon continues to be one of the main threats for the United Nations and Peace keeping operations. The surrogate was validated and tested in conjunction with Armscor's Armour development and its penetration capability deviated less than 1% from the requirement. Several units have been sold. Various other scientific surrogates have been developed such as Explosively Formed Projectile mines and IEDs – to name a few.

Landmine protection validated and certified

"Our foremost goal is to keep the soldiers protected from serious injury."

CSIR principal scientist, John David Reinecke, has taken the lead in training and mentoring new talent in the field of landward sciences research. Young researchers Mangalani Myambo, Morepiwa Mudau, Piet Ramoloko and Thanyani Pandelani amongst others have benefitted from his skills development programme in vehicle landmine protection validation and certification testing that included much practical exposure and rigorous formal and informal training. This work has led to various local and international conference presentations as well as participation in leading international research collaboration by these young researchers. Thus the CSIR is able to provide an up to date internationally compliant vehicle survivability research, test and evaluation capability, that is available and ready to support the SANDF and local industry and train the next generation of scientists and researchers.

Additionally these researchers have the capability of ultrahigh-speed videography that captures up to two million frames a second and a digital flash x-ray machine, all of which can be positioned close to the explosive device, as well as various bio-mechanical test and blast rigs to research detailed aspects of blast impact and crew survivability.

The validation methodology used by the CSIR as the SA authority for validating vehicles for landmine and IED protection evaluation, is internationally recognised. These young researchers' work has thus been of significant value to the local and international defence industry. The CSIR expressly seeks out opportunities to include the scope for skills development in the course of research and projects.

The CSIR follows strict procedures with validation tests that are independently verified. All validation testing is aligned with the SANDF RSA-MIL- STD-37 standard as well as the latest NATO STANAG 4569 AEP 55 volume 2 and Volume 3 (draft) test standards.

A unique facility in the country, valuable and sophisticated test equipment is used to obtain important survivability data from an event that is over in milliseconds. The equipment consisting of modified crash test dummies, data acquisition systems as well as high-speed video recorders are all positioned within the test item which is then subjected to a full scale landmine or IED blast. Over one hundred separate data readings are captured during the tests. Data are processed into survivability estimation using unique validated in-house software.

DEFENCE AND SECURITY ON LAND

Boots to limit antipersonnel blast mine injury

The landmine has been branded as the ultimate indiscriminate killer. Landmines have claimed or impacted the lives of many people in mine-affected countries throughout the world – regardless of age, gender or race. According to the 2011 Landmine Monitor Report by the International Campaign to Ban Landmines (ICBL) there were over four thousand landmine-related casualties recorded worldwide in 2010. Furthermore, the ICBL stated that whilst the Mine Ban Treaty has 160 signatory parties, there are still three countries actively laying antipersonnel mines, while twelve countries have been identified as active antipersonnel mine producers. At last review in August 2011, twenty countries within the African continent remain mine affected.

With the severity of the landmine threat in mind, the CSIR has undertaken work to investigate and quantify the injury mechanisms resulting from the detonation of antipersonnel blast mines. The research resulted in the development of a human Surrogate Lower Leg (SLL) which approximates an actual human leg in terms of geometry and the type of materials selected for its construction. The SLL is intended for destructive testing in order to assess the degree of tissue and bone damage sustained, as well as to estimate the potential levels of amputation. The SLL differs from other surrogate legs in that it employs a unique sensor system capable of measuring the shock or stress wave progression through the leg in microseconds. The sensor system is under on-going development and refinement.

Using the surrogate lower leg with a newly-developed test and evaluation system, the CSIR is in the process of developing a prototype 'mine boot'. The intention is to develop a boot that can prevent any amputation in the event of small antipersonnel mine detonations as well as to mitigate tissue and bone damage during larger antipersonnel mine detonations, as far as possible. The prototype mine boot is in the final stages of testing and development. It is envisioned that the final product will be available in both full boot and strap-on-sole user options, making it applicable to commercial demining activities as well as military use where mobility cannot be restricted with permanent heavy equipment.

Autonomous mule to share the soldier's load

The CSIR is undertaking development of an autonomous mule as a means to reduce the workload of operators in the field undertaking tasks such as border and other security patrols, soldier equipment transportation and squad support. One particularly important capability of the mule is that it can track and follow pre-defined targets, allowing it to participate in convoys or follow squads autonomously.

Aside from carrying excess equipment, the platform could also be used for tele-operated terrain reconnaissance.

The focus of the CSIR's effort is on the autonomy of the platform, as opposed to its construction. The platform is equipped with a high-speed, three-dimensional (3D) laser range finder – used for developing 3D models of the local terrain for path planning. It also has an omni-directional camera which provides operators with a 360° view of the operating environment.

In a civilian context, potential examples include haulage of ore in mines, sowing and harvesting of agricultural crops, and other transport applications. In these applications, an autonomous robot would be able to reduce the burden of simple tasks while allowing control to be referred back to the operator in periods of uncertainty.

DEFENCE AND SECURITY ON LAND

Project: HIRE

The CSIR devised a customised selection test for use during specialised military selection phases. This tool assists the recruiters in determining a cut-off point as a guideline for future candidates' screening and selection processes. This measure has demonstrated the potential of making a significant contribution to the identification of successful candidates at a very early stage of specialised military selection phases. Most recently, the work on Project HIRE included an investigation into Positive Psychology aspects of resilience as well as achievement motivation in the Specialised Military context, studied from an African perspective with specific attention to cultural factors.

Expert technical support for immovable asset management in the Department of Defence

The CSIR undertook a four-year immovable asset management project for the Department of Defence (DOD) which involved a performance assessment of its immovable asset base to ensure optimal use and management and compliance to legislation. This is a service by the CSIR's Immovable Asset Management Programme – a group that provides decision support to the public sector in order to improve the efficiency and effectiveness of the public estate as required by the Government Immovable Asset Management Act, No 19 of 2007, the Public Finance Management Act, No 1 of 1999 and related policy and legislation.

The object of legislation is to ensure a uniform framework for the management of immovable assets by a national or a provincial department in support of its service delivery objectives. Immovable assets are described as land and any immovable improvement on that land which has enduring value and consists of assets of residential, non-residential or of an infrastructural nature. It includes installed machinery or equipment that form an integral part of immovable assets and covers all state-owned and leased assets.

A CSIR-developed Immovable Asset Management software system is used as a tool for strategic decision making through the life cycle of assets – from planning to effective utilisation and eventual disposal.

The main objective of the technical support by the CSIR was to assist the DOD to create an enabling environment for the efficient management and maintenance of facilities that will allow them to:

- comply with all the legal and statutory prescripts governing immovable asset management in the public sector;
- undertake asset management activities within an Integrated Asset Management Policy Framework;
- maximise the service potential of existing assets by ensuring that they are appropriately used and maintained and
- ensure that, through a preservation programme, all DOD facilities are:
  - "fit for service"– desired condition
  - "fit for purpose" – functional and suitable.

Applied psychological and behavioural research in support of specialised African military organisations

Recruiting, selecting, training and retaining top calibre soldiers in the specialised military domain is a key challenge worldwide. With high standards comes high attrition rates and topping the list of most behavioural and social science research agendas within the specialised military is understanding the unique combination of issues involved in the successful completion of specialised military training. In South Africa and the rest of Africa, significant investments are being made to improve candidates' training success rates. The diverse and varied attributes required to successfully complete a specialised military training cycle entails rigorous research with the emphasis on ensuring that the research is contextualised and valid for the scenarios it must support.

Since 2004, the CSIR has built up an Applied Behavioural Research Capability focusing on the identification, exploration, measurement and contextualisation of non-cognitive attributes like, among others, achievement motivation during Specialised Forces Training, in order to contribute to the improvement of qualification rates through a combination of Quantitative and Qualitative research. The research focuses on the African soldier and the African context. With the continent's multi-cultural (individualistic and collectivist) composition, the meaning and understanding of concepts such as "achievement", "happiness", "motivation", "success", "leadership", "determination" and even "intelligence" may differ significantly between the various cultural groups.

The research includes a combination of cognitive and non-cognitive characteristics that contribute towards a successful career within specialised military organisations in Africa. Stress and Resilience studies focus on classic and contemporary studies of combat stress and its consequence. Another focus area is military leadership – to gain insight into leading people in the contexts of diverse and dangerous environments. The research is undertaken across a considerable sphere from the individual to group dynamics and includes psychometrics, recruitment, selection, and training, resilience and morale through to organisational development, climate surveys and social processes.

DEFENCE AND SECURITY ON LAND





From the air to the ground: 'Kit Cart' carries the heavy weapons load

The CSIR developed a load carriage system for the Infantry Formation that could be used by airborne forces who need to move weapon systems from the drop zone into and between firing positions. The challenge arose from having to handle the 12.7 mm heavy machine gun (HMG) where crews had to deploy the weapon system by hand or attached to their combat dress. Battle jackets are not designed for the fitment and transport of support weapon systems or the ammunition. Also, because of the weight of the weapon system, it would make deployment extremely tiring and by limiting the amount of ammunition that can be carried by the crew, the effectiveness of the engagement is also limited.

Initially, the aim was to develop a tailor-made light-weight load carriage system that would enable the motorised and airborne infantry to deploy the 12.7 mm HMG with relative ease. However, the project study revealed that the problem of load carriage applies to all Batallion support weapon systems as well as general load carriage.

This led to the final design and development of a qualified cart system that can be air delivered by means of the standard palatalized deployment system in use by the airborne crews. The modular design allows for quick deployment, interchangeable wheels and easy field maintenance. Future development will include the integration of an electric drive system to optimise deployment capabilities.

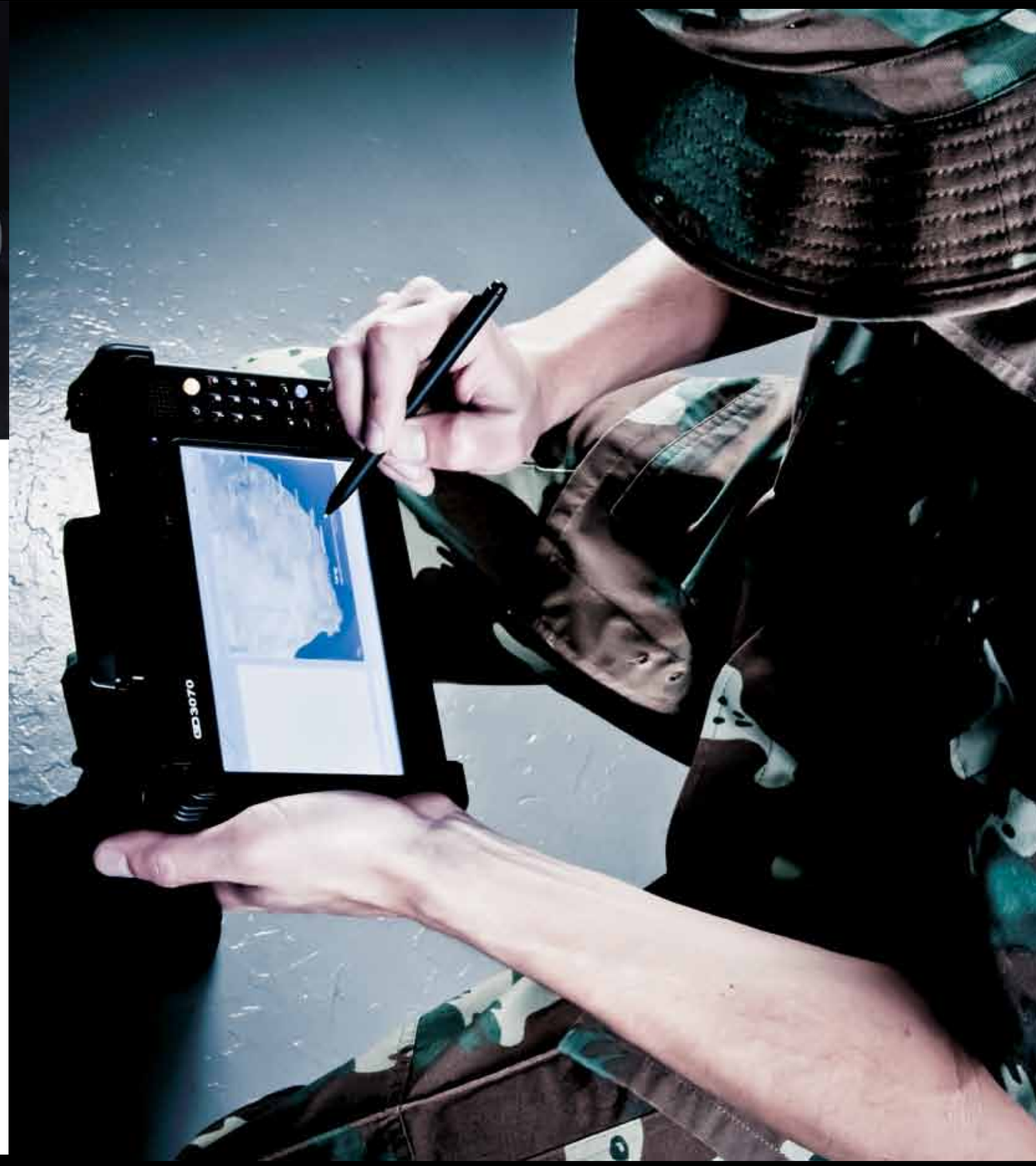
Rapidly responding to new responsibilities: Concept development and experimentation to the rescue

It is crucial that the SA National Defence Force (SANDF) has the ability to adapt to rapid changes during missions. Also, their sphere of duty is expansive ranging from, for example, supporting large national events such as the FIFA World Cup in 2010, to supporting and sustaining peace support efforts or protecting the borders of South Africa. The CSIR established a Concept Development, Experimentation and Simulation process to assist the SANDF in rapidly developing new concepts and to test technology solutions. This process includes the use of simulations to evaluate options – without excessive costs – to determine what tools or ideas should be further pursued. Laboratory experiments ensure that any risks are addressed and mitigated before expensive field experiments are conducted.

The CSIR recently completed a cycle of simulation, lab experiments and field experiments in support of the SANDF's border management efforts. The experiment demonstrated successfully the benefit of integrated tactical intelligence and tactical command and control utilising equipment that was originally designed for conventional war scenarios. The experiment was based on integrating tactical intelligence sensors with the tactical command and control system. Existing radio infrastructure could be used – made possible by an interoperability gateway.

Based on the successes of the Concept Development Experimentation and Simulation process, other arms of service such as the SA Army and the SA Air Force are also now utilising this capability at the CSIR to address new challenges.

DEFENCE AND SECURITY ON LAND



Explosives and demolition support to the SANDF

The CSIR offers the scientific expertise to support specialised operations with chemical product design – i.e. chemicals or explosives that are used to develop new devices and techniques to be used in a specialised combat environment. Research areas include explosives and pyrotechnics, specialised adhesives, explosive effects as well as insensitive munitions and replacement of old munitions.

The expertise is used in basic demolition and combat demolition training as well as to support astute procurement of the right and effective specialised equipment and goods.

Training performed to the SANDF has a strong mathematical base and includes the calculation of charge mass and the placement of charges (e.g. wood or steel) which is critical to the success of a detonation.

Based on this expertise, the CSIR was able to support the rehabilitation of areas of the Kruger National Park where derelict and defunct man-made dams and waterholes needed to be removed. Not only negatively impacting on the natural wild life in the Park, these structures also became home to poachers, illegal immigrants who used it as hide-outs. The demolition of artificial dam walls also re-covered free-flowing rivers that helped the natural migration of fish species within the river.

Web 2.0 concepts for situation awareness and decision support

Free software – be that commercial and open source based – is well used to develop frameworks on which web-based and mobile applications can be implemented. This allows for the translation of Web 2.0 trends and technologies to military benefit, specifically in the domains of situation awareness and decision support.

Popular applications such as Facebook® and Twitter® as scrutinized for application in the military domain, but in safe, controlled conditions where information security is not compromised. This is done by building customised, dedicated applications, that are under control of the researchers, and not exposed the entire, open internet.

The aim is to improve situation awareness from the tactical, soldier level, right up to the commander level. The same is pursued for decision support. In order to evaluate such software, real-world problems areas are used, such as the complex and multi-faceted role of border safeguarding.