Reinventing the future through research

In a mere five years the University of Johannesburg (UJ) has demonstrated its prowess in diverse fields – whether setting trends in sustainable energy technology, leading the way in research into water purification and the detection of chemical and biological pollution, or on the forefront of developing a global plant DNA barcode system – the institution is fast becoming a significant beacon on the higher education landscape. Academic exchange between peer institutions from around the world is ongoing.

Groundbreaking technology assists with alleviating energy crisis

Professor Vivian Alberts

A public-private partnership between the university and private investors is working on a plant in Paarl in the Western Cape to commercialise thin-film technology in South Africa that offers consumers a cheaper and highly efficient alternative to standard solar panels.

This groundbreaking solar technology is the result of over 13 years of research by UJ's Professor Vivian Alberts. Unlike standard solar panels that contain a 350 micron-thick silicon layer, Alberts' panels make use of copper, indium, gallium, sulphur and selenium.

This revolutionary thin panel is approximately five microns thick, compared to human hair which is 20 microns thick, and is dramatically lower in cost to produce than the standard solar panels. The elements used in the panels are all semiconductors, making this technology far more effective in attracting heat. Shareholders in the project include petrochemicals giant Sasol, the Central Energy Fund, the National Empowerment Fund and the university.

Improving the quality of life through water purification

UJ's commitment to improving the quality of life, for society at large, is reflected in the institution and Johannesburg Water (JW) having signed a memorandum of understanding (MoU) that lays a foundation for the two entities to collaborate on research and development projects in the areas of water and sanitation.

This initiative assists the utility in benchmarking its performance and thus ensuring the enhancement of its efficiencies and competitiveness. UJ, on the other hand, will be afforded an opportunity to further develop research-based approaches to long-term strategic planning linked to economic, social and other areas of development.

The collaboration explores and develops new knowledge and technology, specifically in water nanotechnologies, water purification, and waste-water treatment, as well as innovation in water analysis across UJ's various disciplines.

The area of water nanotechnology is particularly important as it is a new generation of technology that holds great promise for waste-water treatment, water quality assessment and other environment applications," says Professor Bhekie Mamba at UJ's Department of Chemical Technology.

The alliance also sees UJ providing workplace learning opportunities to JW employees and other meaningful interventions that address the shortage of scientists and engineers in this service industry. JW has accredited water laboratories, excellent state-of-the-art equipment and this presents an opportunity for the training of scientists towards obtaining higher degrees at UJ.

This partnership also provides a meaningful learning experience to prospective students at UJ and will contribute significantly to the body's efforts to produce a skilled workforce required to support its mission of providing all the residents of Johannesburg with access to quality water and sanitation services."

"It is encouraging to see JW and UJ forge partnerships that contribute to the development of the industry they operate in as this will translate our technological advances into socio-economic gains for the residents of the city," says Professor Derek van der Merwe, Pro Vice-Chancellor and Vice-Principal, UJ.

BioVault secures cyberspace

Professor Basie von Solms

In a landmark scientific breakthrough, UJ researchers Professor Basie von Solms and Dr Bobby Tait, have developed BioVault, a system that allows biometric data such as fingerprints and iris patterns to be used to securely access computer systems, encrypt and decrypt data and digitally sign documents.

BioVault prevents biometric tokens, acquired in an unauthorised way, e.g. a fingerprint lifted from a glass, to be used by an unauthorised person to masquerade as the real user. Further uses of BioVault include using a biometric token as an encryption and decryption key for securing data during transit over the internet, and also for digitally signing an electronic document."

"It is generally accepted that the use of passwords for access purposes is not very secure, as the computer system can only verify that the password is correct, but not that the password is offered by the authorised owner – there is no link between the password and the owner, and the owner is therefore identified and authenticated (verified) indirectly," says Von Solms. This fact makes it easier for an unauthorised person to use a stolen password to get unauthorised access to the real owner's information. A significant percentage of cyber crime is based on this loophole.

Using biometric tokens can eliminate this problem, because such an approach verifies the owner directly rather than indirectly, thus making the whole process much more secure. However, problems with the wider use of biometrics over networks were related to the fact that a biometric token can be intercepted, and re-used (replayed), or that a biometric can be acquired from the user's contact with the environment, and then be used in an unauthorised way. These problems inhibited the wider use of biometric tokens over insecure networks, and prevented their being a viable alternative to passwords. "BioVault addresses these problems and it is now possible to use biometrics more securely," say Von Solms and Tait.

UJ's science and technology to leave its mark on the World Cup

UJ's science and technology department will leave its mark on the Fifa 2010 World Cup with a partnership between the institution's Department of Sport, Movement Studies and Scottish company Sports Lab, which will see a new laboratory at the university, known as the UJ Sports Lab, become the first ever Fifa-accredited artificial turf testing institution on the African continent. This laboratory will be able to test the quality of artificial pitches such as the 52 which are being laid in each of the South African Football Association's regions locally, greatly reducing the cost of these pitches. "The third generation artificial turf systems have especially long pile or 'blades of grass'. The infill is a combination of siliceous sand and rubber granulate that resists compaction over time, if properly maintained," says Professor Paul Singh, Director of UJ Sports Lab. "New yarn grades, like multiple monofilament polyethylene yarns, and improved underlay systems, guarantee optimal playing characteristics. Low friction parameters and ball rebound characteristics equal to natural grass make artificial turf now an accepted surface for football," he adds. The 2010 Fifa World Cup Organising Committee South Africa (OC), as part of its 2010 Legacy Programme, has already set aside R81-million for the construction of 27 of the artificial pitches, which will provide for construction of pitches in rural and township areas. Already nine sites in previously disadvantaged communities in South Africa have been identified for construction. While one of the pre-cursors to South Africa winning the 2010 Fifa World Cup bid was that the tournament would leave a legacy in South Africa and Africa, the OC and Fifa insist on that legacy being one of quality. The new UJ testing facility, currently under construction, will be able to test pitches up to Fifa 1 Star recommended levels the minimum artificial pitch requirements for community football. "We have an opportunity here to leave a legacy. In this case it is one of quality sport pitches and facilities. The new lab will also equip South African scientists with unique skills on the African continent. This is also an opportunity for training our students, an opportunity to expose them to the latest developments and technologies in artificial pitch development which will mean that our students can be employed anywhere in the world," says Singh.

Plant DNA barcoding ensures future biodiversity

UJ's botanists' ground-breaking research played a key role in identifying a standard plant DNA barcode. The research, conducted by the Department of Botany and Plant Biotechnology's Professor Michelle van der Bank and her team, provided the foundation for the widespread use of DNA technologies to identify plants.

Now, South Africa's rare and sought-after cycads will be protected by UJ's DNA barcoding of protected timber and traded trees in Africa, which forms part of the TreeBOL Africa project, headed by Professor Van der Bank. This initiative assists customs officials in clamping down on illicit trade in endangered plants. This is one of many plant DNA barcoding projects currently at UJ.

"Plant barcoding provides an efficient means by which we can discover the many undescribed species that exist on earth. This discovery is important because understanding biodiversity is crucial to long-term human existence on the planet. It is extremely exciting and we can foresee that researchers around the world will eagerly begin sequencing plant species and thereby contributing to the goal to complete DNA barcodes of at least 500 000 species in the next few years," says Van der Bank.

"Furthermore, the UJ barcode library will deter illegal trade in plants, specifically cycads, by preventing unscrupulous dealers and buyers from presenting rare plants as more common species. As visual identification is almost impossible once the leaves have been stripped for transport purposes, DNA barcoder will provide conservation officials with a fool-proof way of identifying seized cycads", adds Van der Bank.