Training the next generation of engineers

The new Engineering 3 Building and Parkade on the University's Hatfield Campus has been under construction for the past two years. It was officially opened on 25 August 2011 by Dr Blade Nzimande, Minister of Higher Education and Training, and Prof Cheryl de la Rey, the University's Vice-Chancellor and Principal. It will significantly enhance the University's ability to train an increasing number of engineers to meet the critical national shortage of these important skills.

The University invested more than R400 million in the construction of this innovative, environmentally friendly, multifunctional building. Additional funding for the expansion of its engineering facilities was received through a government grant.

The new building has six lecture halls with a total of 1 800 seats, a drawing hall with 450 seats, and two levels of laboratories and offices totalling 10 800 m^2. The entire floor area of the building is approximately 40 000 m^2. A seven-lane entrance eases traffic flow into the parkade, as well as onto the campus.

The parkade comprises four-and-a-half levels of parking (two-and-a-half of which are underground) and makes provision for 996 parking bays. This consists of reserved parking for lecturers and university staff, as well as open parking for students and visitors. The parkade makes use of a pay-on-foot system and will also be used over weekends to provide parking for spectators attending events at the neighbouring Loftus Versfeld rugby stadium.

At the official opening, Dr Nzimande commended the University for "putting taxpayers' money to good use". He said the new facilities would contribute significantly to the role that the University can play in helping the higher education system produce young engineering graduates for the country and the region. He also expressed his delight in the fact that new life is being breathed into South African universities through infrastructure development initiatives, and lauded the University for its strong ties with industry.

Prof De la Rey said that the additional engineering facilities would enable the University to accommodate the annual growth in student numbers, which was in accordance with the University's growth strategy.

"Over the past five years, our student growth rate has been close to 5% per annum. We currently have just over 45 500 registered contact students and another 20 000 students in our distance education programmes. This makes us one of the largest universities in the country and the largest of the research-intensive universities," she said.

As a public university in a developing society, the University of Pretoria needs to be responsive to the human capital development needs of the country. According to the Vice-Chancellor and Principal, growth will be pursued in areas where the University already has expertise, capacity and infrastructural resources. This will enable the University to simultaneously meet its aspirations for academic excellence and sustainability.

Prof De la Rey regards the completion of the new Engineering 3 Building as a significant milestone in enabling the University's institutional strategy. She describes engineering as one of the University's flagship professional programmes, which will be grown further to meet national needs.

According to Prof Roelf Sandenbergh, Dean of the Faculty of Engineering, Built Environment and Information Technology, the University of Pretoria currently delivers 26% of all engineering graduates in the country. It is committed to making a significant contribution to the training of the next generation of engineers.

The new facilities include lecture halls, tutorial facilities, teaching and research laboratories and a CDIO centre, which forms part of an innovative, team-based educational framework where students go through the cycle of conceiving, designing, implementing and operating (CDIO). The offices

The new Engineering 3 Building on the Hatfield Campus.

and research facilities were designed to facilitate the building of research groups around specialised laboratories with close interaction between research leaders and students, and between research groups through the provision of communal spaces. Further expansion in the form of a study centre to support student learning and group work is planned for the near future, while more facilities are proposed as part of long-term growth plans.

Environmentally friendly design

The design of the building is primarily determined by pedestrian flow. A ten-metre wide concourse forms the central axis to the building and becomes the main feeder to secondary walkways leading to lecture halls, offices and laboratories. External balconies to the east and west with high-level planters, green screens and benches provide relief pockets. The concourse connects with the extension to the Music Library to the east and a new ramp to the north connects Engineering 3 to the western podium of the Aula, where a pedestrian bridge across the Ring Road links up with Engineering 2. On ground level, a cultural route runs to the east of the building, connecting the Musaion, Amphitheatre, Rautenbach Hall and Aula. The orientation of the building, governed by the parkade below, resulted in deep-set windows with high-performance glass and intense screening to the west façade. Strong façade lines and concrete frames were used to reflect the architecture of the adjacent buildings.

In its design brief, the University challenged the architects to come up with a design that is in line with the current international trend to make buildings as environmentally friendly as possible. The University made it clear that the building needed to be designed in terms of the principles of the Green Building Council of South Africa's Green Star Rating System. Although a Green Star Rating System has not yet been formalised for a mixed-use educational building, the design team employed best practice in all regards to register the development in future.

Such a rating recognises and rewards environmental leadership. It is based on the innovative use of design, construction and operational practices that significantly reduce or eliminate the institution's impact on the environment. In addition, the design, material and technology used should lead to a reduction in energy and resource consumption and create improved human and natural environments.

The conceptual design focused on assimilating the entire brief in the most cost-effective, yet sustainably responsible way. Additional capital expenditure was only sacrificed if it could be retrieved on lifecycle costing or proven as environmental investment.

Environmentally friendly elements were also incorporated to regulate temperature. Chimneys visible on the western façade are used to naturally extract relief air from ceiling voids above the labs and offices. Chimneys are allocated above the main and secondary concourses. These, together with mechanically operated windows and louvres, assist in naturally ventilating the public spaces in the building. A central building monitoring system controls all levels of air volume and temperature in the building. Technologies such as insulation to the walls and to the slab below offices and laboratories, the use of variable air volume mechanical systems and motion sensors for lighting, as well as rainwater harvesting, were implemented to reduce the energy consumption of the building.

Some of the innovative design elements that were incorporated to shade the building and reduce heat induction include the following:

- Performance glass reduces solar radiation by up to 48% in summer and stops heat from escaping in winter.
- Solar screens eliminate direct solar radiation by approximately 50%. The screens are made up of louvres and mesh screens that have been designed in accordance with year-round sun angles for summer and winter conditions, as well as the daily angle of the sun.
- Isolation material was applied to the underside of the slab between the underground parking garage and the first floor of the building. This minimises heat loss in offices and lecture halls during winter months.
- Extensive use was made of plants to shade the building against the sun. Special frames were designed that house plant-holders that can easily be removed and replaced.
- Use was also made of environmentally friendly construction material such as concrete, clay bricks, glass, ceramics, organic wool isolation, gypsum boarding and Envirodeck, a composite decking system made from recycled plastic and timber.

Energy efficiency

A number of energy-efficient measures were incorporated in the design of the building. This includes a naturally ventilated atrium, filled with plants that help reduce CO_2 emissions. As a result, less air conditioning is required to cool the building. This means that the building's energy efficiency is measured at 25% below the requirements in terms of SANS 204 (South African National Standard: Energy Efficiency in Buildings).

Spill-over air from mechanically ventilated lecture halls is used to cool down public areas in summer and heat these areas in winter. A chimney convection system, which draws warm air out from ceiling voids and relieves it at roof level, was also incorporated in the design. Apart from the energy saving, the system also allows for the inflow of fresh air, which averts "sick building syndrome".

A rainwater harvesting system has also been included in the design of the building. A 50 000-litre tank allows for water to be redistributed throughout the building for irrigation, as well as being available for fire control purposes. Should the water drop below a certain level, the tank will be filled with municipal water, which will cool the building down even further.

Air conditioning is provided in the form of a chilled water variable air volume system, which greatly reduces energy consumption. The system makes use of a chiller to cool water down. The water is then distributed throughout the building. The system automatically measures the temperature on the inside and outside of the building, and then automatically adapts the inside temperature to a comfortable level. A building monitoring system automatically controls and monitors all systems in the building, including the use of electricity, and the monitoring of water and CO_2 emission levels.

All sanitary fittings are provided with economy cycle water closets, and taps are fitted with control valves to minimise water flow periods. In addition, chilled slab mechanical systems were used, whereby water pipes were cast in the slabs to heat or cool the slab. The system is quite complex and new in South Africa and results in a massive saving on the life cycle costing of the system.

Power-saving techniques include the use of occupancy sensors that detect the movement of nearby people or objects such as cars. The system eliminates the need to burn lamps in areas that have not been occupied for at least 30 minutes. Depending on the location and application of the area, power saving is achieved. These sensors are mostly employed in the parking areas, lecture halls and engineering laboratories of the new building.

- Total floor area of the building: 40 000 m^2 = 8 rugby fields
- Total excavation: 57 600 m^3 = 1 280 average swimming pools
- Total concrete volume: 16 800 m^3 = 373 average swimming pools
- Formwork: 65 000 m^2 = 13 rugby fields
- Reinforcement: 1 570 000 kg = 994 km of 16 mm rebar (from Pretoria to Beaufort West)
- Number of bricks: 1 180 000 = row of 270 km end to end
- Painted surfaces: 67 000 m^2 = 8 375 litres @ 8 m^2 per litre coverage (1 675 five-litre tins)
- Glazed area: 2 242 m^2 = half a rugby field
- Average of 6 m^3 trucks left the site every three-and-a-half minutes over the 64-working-day contract period

→ *The new Engineering 3 Building on the University's Hatfield Campus.*