



**Prof Wynand Steyn**  
Dept Civil Engineering  
University of Pretoria  
wynand.steyn@up.ac.za



**Prof Hannes Gräbe**  
Dept Civil Engineering  
University of Pretoria  
hannes.grabe@up.ac.za



**Prof Christo Venter**  
Dept Civil Engineering  
University of Pretoria  
christo.venter@up.ac.za

# Transportation Research and Education at the University of Pretoria

## INTRODUCTION

Transportation engineering is one of the four focus areas of the Department of Civil Engineering at the University of Pretoria (UP). Students are educated on both undergraduate and postgraduate level in the disciplines of transportation, pavement and railway engineering. Current research projects focus on different aspects of these three disciplines. About 100 undergraduate students graduate from the department annually, while around 20 students achieve the Honours degree in Transportation Engineering and Applied Sciences, and five students the Masters degree in Transportation Engineering and Applied Sciences annually.

It is the Department's objective to ensure that engineers are produced with a strong foundation in transportation engineering, and that postgraduate students can specialise in this vital area in the South African society. Research is conducted with both local and international partners, focusing on improvements in current methods and the development of novel materials and techniques to ensure

that transportation in South Africa remains effective and efficient.

## UNDERGRADUATE TRAINING

The undergraduate programme consists of four years of full-time study. During this period students are exposed to transportation through five subjects, spread over the second to fourth academic study years. Attention is given to subjects focusing on road building materials, pavement evaluation and design, transportation engineering, transportation planning and rail engineering. In the final undergraduate year the student's research project can be conducted with a focus on one of the three transportation disciplines, while a transportation-related design project, concentrating on a case study, needs to be completed by all students.

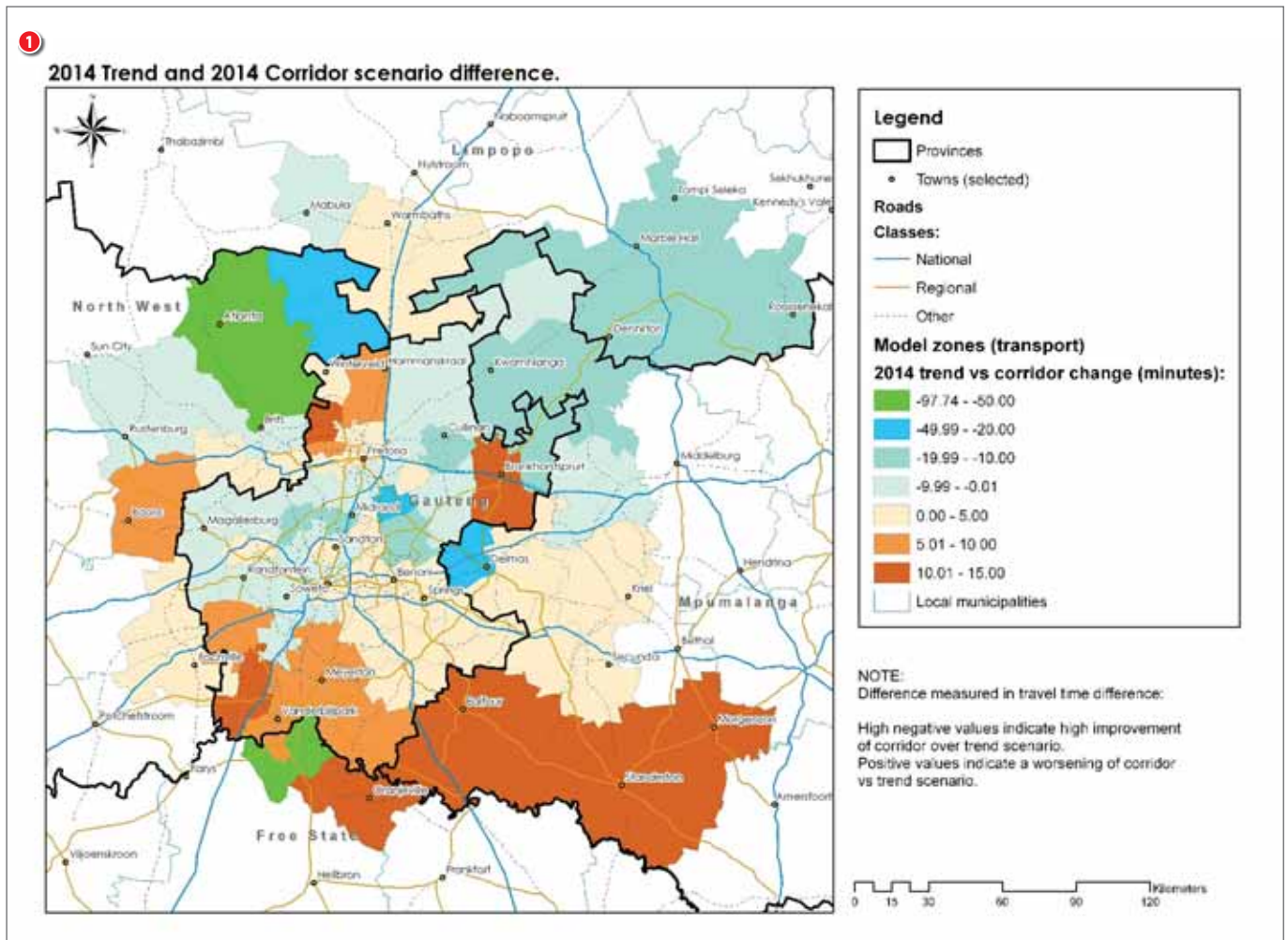
## POSTGRADUATE TRAINING

The postgraduate programme at the university provides the option of studying towards honours, masters and doctoral degrees. The honours and masters degrees can be obtained as degrees in

Transportation Engineering (for students with a BEng first degree) or in Applied Sciences with a specialisation in Transportation Technology (for students with a BTech qualification). There is a choice between 20 transport-related postgraduate courses, and students are required to pass at least six courses for an honours degree. The master's programme requires either a full research dissertation, or a combination of a research project and two Advanced Transportation courses to be completed. Subjects are lectured using a combination of permanent staff and local and international guest lecturers. Selected courses are presented as short courses, providing industry partners who are not enrolled for full degree programmes with the option of improving their knowledge.

## RESEARCH

Research is conducted in the three main disciplines in the transportation area: Transportation, Pavements and Railways. Postgraduate students form part of the research teams in most of these projects, to ensure that postgraduate research topics



are relevant and applicable to industry needs. Current research projects deal with the following topics.

**Transportation Engineering**

Research in transportation engineering focuses on three areas, reflecting what we believe to be some of the key challenges facing the provision of sustainable multi-modal transport mobility in South Africa.

*Impacts of Change research programme*

The rapidly evolving transport environment, underpinned by the significant investments currently being made in public transport and road capacity, will have far-reaching impacts not only on the way we travel, but also on wider spatial and socio-economic systems in the future. The Impacts of Change research programme is aimed at achieving an early understanding of the ways in which commuters, property developers and the general public are affected by, and respond to, interventions such as Gautrain, Bus Rapid Transit and open-road tolling in Gauteng, with the ultimate aim of improving evidence-driven policy formulation and integrated planning. The programme is

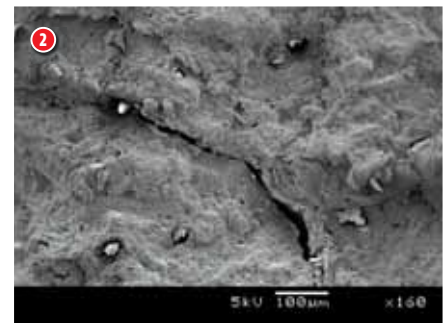
**1** Visual output from transport scenario runs using UPTrans simplified strategic transport model

**2** SEM image of typical pavement base course material

an emerging multidisciplinary collaboration between students and professionals in the civil engineering, real estate, town planning and sociology disciplines, and uses a mix of long-term behavioural surveys, traffic modelling and qualitative approaches. It is funded by the United Nations Development Programme and government and private sector funders.

*Strategic land use/transport modelling for developing countries*

The UPTrans strategic transport model was developed locally as a tool for quick-response scenario planning, specifically in response to the data and human capacity limitations typical of planning environments in developing countries. UPTrans was first tested and validated in the Gauteng Global City Region, in collaboration with the CSIR and the HSRC. Development work is currently continuing on network aggregation procedures



that will simplify the transport network specification step in model building; it is being undertaken in collaboration with researchers in India and Uganda. An example of the visual output of UPTrans is shown in Figure 1.

*Public transport operations*

The focus here is on the modelling and assessment of Bus Rapid Transit (BRT) operations, using field measurements and computer simulations. An example is the study of passenger queuing and movement patterns through BRT stations, based on observations at Rea Vaya BRT stations in Johannesburg, which is being used to develop guidelines for the design and operation of narrow BRT stations under local conditions.



3 Tubular Modular Track test site at Burnett St, Hatfield, Pretoria

4 Remote video monitoring to measure track and foundation deflection



in road building, such as cement, fly ash and clay fractions, are often nanosized, and modern equipment, such as the scanning electron microscope (Figure 2) and atomic force microscope, provide new insights into the performance of these materials. The properties of some of these materials on the nanoscale can also be evaluated and linked to the macro-sized effects often observed in pavement behaviour. Nanotechnology opens new avenues for research into pavement material behaviour and the application of novel materials in pavements.

### Railway Engineering

Rail research at UP is currently being carried out as part of a THRIP-funded project with industry partners Transnet Freight Rail, E-Logics and Esteq Engineering. The three focus areas of the research are: Track Performance, Condition Measurement Technologies and Maintenance Management.

#### Track Performance

Numerical models are developed to predict the performance of conventional

### Pavement Engineering

#### *Effects of road riding quality on tyre loads and on cargo damage and logistics*

In this research, supported by SANRAL, the CSIR and the California Department of Transport (Caltrans), the effects of road riding quality on the vehicles and cargo travelling on the road are evaluated and analysed. This is done to assist in developing appropriate traffic loading inputs for pavement designs, and to evaluate the potential damage caused to

the vehicles and cargo on a specific road as a result of changes in pavement condition. Quantification of these effects assists in the optimal management of road networks through timeous maintenance actions.

#### *Nanotechnology applications in pavement engineering*

Nanotechnology evaluates the properties of materials at scales of less than 100 nm. Materials traditionally involved

and non-conventional (ballastless) track structures. Field instrumentation is used on different railway lines (passenger and freight) and track structures (e.g. Tubular Modular Track – see Figure 3) to measure the response of track systems to normal train loading and environmental factors. Experiments are carried out to develop models that will be able to predict the long-term performance and design life of various track components and systems, thereby enhancing the design cost-effectiveness of rail solutions.

#### *Condition Measurement Technologies*

Condition-based maintenance is becoming the norm in industries where asset care has a substantial impact on the overall success of the business. Optical instrumentation (e.g. remote video monitoring, see Figure 4) is being developed to measure the movement of track components under train loading and at high frequencies. Ground penetrating radar (GPR) is a well-established technology in railway engineering and is employed to measure layer dimensions, ballast

fouling and moisture conditions in railway foundations. These technologies, among others, will be used to develop condition assessment systems that will aid maintenance engineers in planning and executing corrective maintenance at the right time and place. Industry partners for this work include Aurecon, Roadscanners (Finland), TLC Software and TTCI (US).

#### *Maintenance Management*

A proper understanding of railway infrastructure maintenance management is one of the most important knowledge areas in the field of railway engineering. Research is being carried out in collaboration with E-Logics and Amtrak (US) to develop a ballast-tamping model and a rail break management model that will be incorporated into Transnet Freight Rail's Integrated Asset Maintenance Management (IAMM) system. These developments will ensure that track components are maintained to promote reliability, availability, affordability and safety.

## CONCLUSION

The Transportation Engineering programme at the University of Pretoria is well founded and strongly supported by industry, and aims to support the education of well-trained transportation professionals. Potential students interested in postgraduate studies are welcome to contact us.

## CONTACT DETAILS

The staff responsible for the transportation subjects are:

**Pavement engineering:**

Prof Wynand JvdM Steyn  
(wynand.steyn@up.ac.za)

**Railway engineering:**

Prof Hannes Gräbe  
(hannes.grabe@up.ac.za)

**Transportation engineering:**

Prof Christo Venter  
(christo.venter@up.ac.za)

**Departmental website:**

<http://web.up.ac.za/default.asp?ipkCategoryID=2407> 