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Bridge City Railway Station Project

ensuring optimum levels of service through pedestrian simulation incorporating Virtual Reality (VR)

BACKGROUND AND INTRODUCTION

Situated in the Inanda, Ntuzuma and KwaMashu (INK) area, 17 km from the Durban City Centre, the Bridge City development aims to bridge the social divides of the past to create a dynamic, vibrant city precinct that celebrates diversity and sustainability. The INK area was identified as a critical development node due to the high levels of poverty. The precinct promises to be the retail, residential and investment destination of choice for approximately one million people living in the INK and Phoenix areas.

When completed, total investment in this node will be in the order of R5 billion, resulting in the creation of 4 500 residential units and 230 000 m^2 of mixed-use commercial floor area. The Bridge City node is expected to become a catalyst for economic growth in the sub-region. The extension of the rail service into the Inanda area has been identified as a priority project in the rail plan that supports the eThekweni Transport Authority's (ETA) overall public transport strategy.

This project encompasses the construction of a 3 km rail spur from the existing Duffs Road Station to the Bridge City development node in Inanda. The rail service is supplemented by a road-based feeder distribution service that links to the rest of the Inanda, Ntuzuma, KwaMashu and Phoenix areas.

To facilitate the change of modes at Bridge City, an integrated road-to-rail modal interchange has been provided, incorporating a new commuter rail station, minibus-taxi rank, commuter bus rank and related commuter convenience, retail and other facilities. The geographic location of Bridge City and the study area is shown in Figure 1.

The intermodal facility will incorporate transport areas on different levels, linked by stairs, escalators and lifts. Bridge City will, in the near future, be linked to the existing Metro commuter line splitting into four rail lines, serviced at the station by two platforms to cater for the anticipated demand. In addition, 40 bus bays and 150 taxi bays are being provided, including approximately 1 000 parking bays, partly to support the Park and Ride concept.

STATION DESIGN MODELLING APPROACH

Whereas pedestrian simulation modelling of railway station designs has in the past been undertaken to validate completed designs, the application of the PTV VISSIM microscopic modelling software package by Goba for the completed new Bridge City station has led to a re-examination of station sizing principles and a renewed focus on the level of passenger service.

Traditionally, railway stations were sized according to established sets of macroscopic principles based largely on matching predicted demand with flow rate capacities of infrastructure elements such as escalators, stairs, access gates (turnstiles) etc.

These methods, however, do not consider the effects of "micro-peaking" (due to the pulse-like dynamics of the alighting process), nor the interaction of pedestrians with one another and the surrounding obstacles, giving rise to queuing. Delays due to time spent queuing at turnstiles and at other infrastructure items detrimentally influence the perception of the level of service. New ways of assessing queuing and turnstile requirements have been made possible by the application of pedestrian simulation modelling in the station design process.

Goba utilised PTV VISSIM, the world's leading state-of-the-art pedestrian simulation software, for the assessment of the Bridge City station, and together with the in-house VISSIM trained modelling team, recently assessed a further eleven railway station designs throughout South Africa.

For stations such as Bridge City that provide vital interchanges between several public transport modes, pedestrian simulation and analysis are being employed to provide an additional level of assessment to ensure that the levels of service required by the Passenger Rail Agency of South Africa (PRASA) are met.

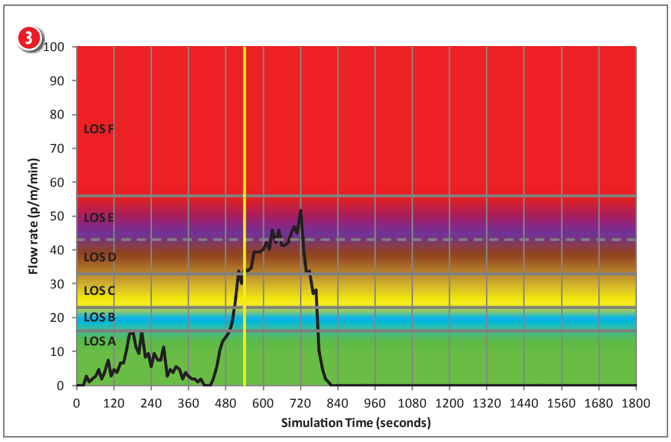
As part of this project, three-dimensional (3D) visualisation, or Virtual Reality (VR), was conducted for the entire modal interchange, including the new rail spur to the interchange.

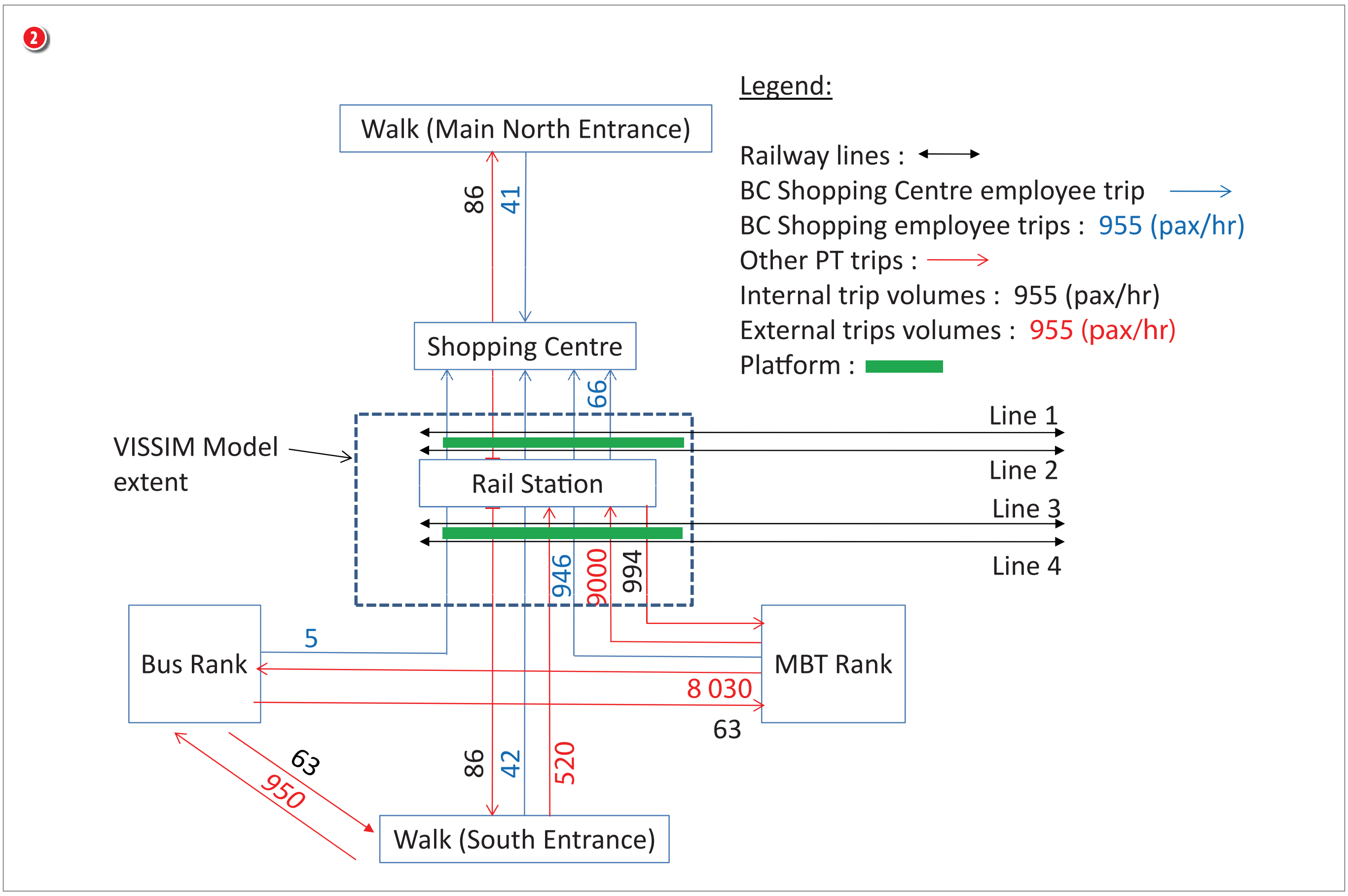
BRIDGE CITY PATRONAGE DEMAND

Figure 2 shows the pedestrian volumes that needed to be accommodated by the Bridge City intermodal interchange. The transfer station is expected to accommodate no less than 20 000 interchanging passengers in the peak hour, excluding the 1 100 pedestrians with trip ends within the Bridge City Shopping Centre.

Such levels of demand at an interchange station with numerous internal origins and destinations result in dynamics that cannot be realistically predicted using static methods of calculation.

1 Study area and location
2 Bridge City 2020 morning peak hour volumes
3 Platform 1 to concourse afternoon peak





In this case, pedestrian simulation modelling during the design process was used, not only to test the proposed architectural layout and associated levels of service based on static calculations, but also to provide input to the Virtual Reality (VR) model. The effectiveness of the evacuation potential of the station was also tested.

An early version of the station layout that was fully compliant with the manual station sizing requirements was activated with pedestrian simulation which provided longitudinal pedestrian density plots of various station infrastructure items such as platforms, staircases (refer to Figure 3), concourses, turnstiles, foyers etc. The result of this analysis was compared to the acceptability criteria objectives of PRASA.

The pedestrian flow rate criteria on staircases, from platforms to concourse level, failed to meet the standards prescribed by PRASA, particularly during the afternoon peak period with the higher alighting loads. The design team responded by recommending that both sets of escalators should run in the ascending direction during this time period only. Any passengers wishing to board during this time would have the option of using the stairs or the lifts.

The updated layout was then subjected to an evacuation assessment where improvements to the escape door widths and platform ramp ends were proposed.

By responding to the key model findings of the analysis of the initial layout, the design team could make changes based on sound reasoning. Furthermore, the effectiveness of the design was assessed according to the required level of service criteria, and the assessment of various scenarios provided the necessary confidence that the optimised design would withstand dynamic load effects whilst providing acceptable levels of service for station users.

4 Platform alighting VR simulation

5 High Speed Access Gate (HSAG) arrangements at the concourse level

The assessment has shown that the station design can accommodate additional passenger volume growth beyond that predicted for 2020 through appropriate scheduling of consecutive trains onto alternate platforms.

The advantages of pedestrian simulation have been recognised by Goba's transport planners as they advance the techniques used to improve spatial requirements for pedestrians, particularly in railway station environments where the effects of "pulse loading" are difficult to analyse.

The diverse possibilities that the VISSIM microscopic modelling environment can be used for, enable a wide spectrum of scenarios and events to be tested. A recent example is the station capacity analysis undertaken for the new Moses Mabhida railway station that needed to accommodate spectators during the 2010 FIFA World Cup event.

For this station, a "supply side" modelling assessment was undertaken to identify the maximum passenger loading that the station could safely accommodate. Once this volume had been determined, specific train coach numbers and appropriate headways during match days could be controlled in order not to exceed the calculated station capacity.

INCORPORATION OF VIRTUAL REALITY (VR)

In response to the client's ambition of creating a world-class station facility, Goba, together with Sunovatech India, developed and tested a 3D VR simulation model. VISSIM output data (from the Pedestrian Protocol Data record) is processed using an advanced 3D VR Processor (SVR Bridge v5.1) that links this data with the objects created and designated in 3D Studio-Max, which then behaves exactly the same as the pedestrians modelled in VISSIM.

This 3D model is then further enhanced by rendering pedestrians and draping infrastructure in standard or high-definition resolution, obtained from real-life photography. Over the past few years, VR in micro-simulation has provided a valuable

6 Platform waiting area
7 A view from the concourse area en route to the HSAGs
8 A view of the ticket sales booths and railing
9 Escalator movement simulation – the glass structure encapsulating the escalators is not merely an aesthetic addition, but has a specific function to restrict smoke ingress to the upper concourse level should a fire break out at platform level

tool to evaluate complex infrastructure proposals. VR not only provides realistic visualisation but also reflects detailed engineering aspects.

In addition to the VR model produced for the Bridge City public transport interchange, Goba utilised similar VR micro-simulation technologies for modelling the Cape Town station upgrade project and also to showcase the proposed new Umgeni Interchange in KwaZulu-Natal. VR provides a new and unique platform to integrate micro-simulation, urban design and existing infrastructure to demonstrate to decision-makers the functionality of the proposed environment before implementation.

With regard to the Bridge City railway station project, the VR simulation outputs were not only instrumental in understanding and testing the proposed design, but also provided a key visual tool for designers to explain the proposal to stakeholders and the public. Typical examples of three-dimensional VR-rendered outputs for the Bridge City railway station are shown in Figures 4 to 9.

CONCLUSION

Goba's application of VISSIM pedestrian simulation software to develop, optimise and validate railway station designs with respect to dynamic level of service criteria has enabled the fine-tuning of platform, concourse, foyer, turnstile and staircase arrangements to ensure that the most efficient use of space and the requisite levels of service are met.

The value of microscopic pedestrian modelling, undertaken through the various station infrastructure upgrade projects, has proved to be extremely valuable in terms of station design in South Africa. It is believed that microscopic modelling, calibrated to local pedestrian behaviour, should be considered as a compulsory aspect of the station design process, rather than a final design check of spatial adequacy.

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REFERENCES

Goba (Pty) Ltd 2008. *Development of an Integrated Intermodal Public Transport Facility in Bridge City – Kwazulu-Natal*. Inception Report, February 2008.

Goba (Pty) Ltd 2010. *Pedestrian Modelling Assessment: Bridge City Station*. Final Report conducted for PRASA, February 2010.

Herrmann, W, Hermant, L F L & Emeran, H 2009. *Pedestrian Modelling in South Africa: A Recent Case Study*, in *Proceedings* of the 28th Southern African Transportation Conference (SATC 2009), Pretoria, South Africa, July 2009.

Hermant, L F L, Ahuja, R, De Gersigny, M, Emeran, H & Herrmann, R 2010. *Applying Microscopic Modelling and Virtual Reality Pedestrian Flow Simulation to Public Transport Interchange Design Evaluation in Durban, South Africa*, in *Proceedings* of the 3rd International Conference, Transport Science and Technology Congress (Transtec 2010), New Delhi, India, 4–7 April 2010.

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PROJECT TEAM

Client
Passenger Rail Agency of South Africa

Project Manager
Focus Project Management
Target Project and Construction Management Services

Architects
Architects Collaborative
Architectural Design Associates

Quantity Surveyors
LDM Quantity Surveyors
Malata & Associates
Vaughan Charles Associates

Engineering Consultants
Goba
Arcus Gibb

Contractors
ENZA Construction
Grinaker - LTA

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