

# **A SYSTEMS APPROACH TO MANAGING R&D IN THE ROAD INFRASTRUCTURE SECTOR IN SOUTH AFRICA**

**Frederik Christoffel Rust**

A thesis submitted to the Faculty of Engineering, University of the Witwatersrand, in fulfilment of the requirements for the degree of Doctor of Philosophy.  
Johannesburg, 2009

## **ABSTRACT**

The importance of science and technology in South Africa in the next decade has been emphasised in the National R&D strategy, and a target expenditure of one per cent of GDP on R&D has been set. Research programmes in transport in the 1990s did not yield the expected outcomes and impact due to severe fragmentation of the programmes and subsequent diminished funding and output. Road authorities and the private sector expressed a need for the improvement of the associated management processes. International work in technology management has focused mainly on linear models of managing the development of hard products for the consumer market. These models are not suitable for the road building industry where the majority of the R&D programmes are aimed at the development of new knowledge, engineering methodology and associated engineering solutions. In addition, the R&D process is complex with many elements and interactions, and thus a simple linear management model is unlikely to yield the desired results. This thesis is aimed at the development of a systems-based R&D management model and tools for road engineering and shows that their implementation has a significant impact on R&D outputs. This study evaluated international best practice as well as the success and failure factors of six local R&D programmes. A developmental research approach was used to identify the problem, develop a solution and test the solution in a number of R&D programmes. The model is based on a systems approach, taking aspects of cybernetics and complexity theory into consideration and is radically different from the linear approaches usually followed in the management of the development of consumer products. A set of analysis tools supporting the strategic model was developed. These include a strategic needs determination process, the technology tree tool and a research effectiveness measurement system. The new conceptual model and the associated analysis tools were implemented in four significant research programmes in the public sector, private sector and research organisations. The emphasis was on managing the synergy between the programmes in a holistic approach, thus enhancing the outcome and impact of the programmes. It is shown that the implementation of the models and tools had a significant effect on the R&D output from these research programmes. Finally, two protocols for the use of the model and tools were developed and their use in the Labour-Intensive Construction field demonstrated.