THE ROLE OF A UNIVERSITY IN EDUCATION AND TRAINING IN THE FIELD OF NANOTECHNOLOGY
The Case of the University of the Witwatersrand

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Abstract: The study investigates the role of the University of Witwatersrand (Wits) in the field of nanotechnology, with special focus on the experiences and challenges faced by Wits. Wits has responded to the South African National Nanotechnology Strategy which aimed at ensuring that South Africa is ready to optimally use Nanotechnology to enhance its global competitiveness and sustainable economic growth. The study reveals that Wits has provided research and educational opportunities in the field of nanotechnology. The study however shows that Wits faces the quantitative challenge of an inadequate number of Schools that are involved in nanotechnology activities. This study therefore adds to the global discussion on the role of the University in the field of nanotechnology.

Keywords: nanotechnology; education strategy; globalization; collaboration; knowledge production; university policy.

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INTRODUCTION

Nanotechnology is now regarded globally as the technology of the 21st century. Known also as the technology of the very small, nanotechnology is the 'complete control of the structure of matter, building complex objects with molecular precision' (Drexler, 1988). Uddin and Chowdhury (2001) also define nanotechnology as 'involving the manipulation and controlling of individual atoms and molecules to designing and creating new materials, nano-machines, and nano devices for application in all aspects of our lives'. Nanotechnology therefore can be broadly defined as the science and engineering that studies and creates materials, systems, processes, and so on at nanometre (10^{-9} m) scale. This technology is truly interdisciplinary in that it requires a joint effort between the disciplines of physics, chemistry, biology, medicine, chemical, electrical and mechanical engineering, as well as material science (Uddin and Chowdhury, 2001). Nanotechnology also has many applications ranging from computer, information, biotechnology, electronic, aerospace defense, manufacturing, environment, medicine and so on. In fact, every sector of any country's economy is to be profoundly impacted upon by nanotechnology (Drexler, 1988; Uddin and Chowdhury, 2001; Meyyappan, 2004; Fonash, 2001; Roco *et al.*, 1999; Roco, 2001, 2002; Hung and Chu, 2004; Hassan, 2005; Glenn, 2005).

Furthermore, nanotechnology promises more for less, that is, it involves smaller, stronger, cheaper, lighter, faster devices with greater functionality and efficiency, using fewer raw materials and consuming less energy (Meyyappan, 2004; Uddin and Chowdhury, 2001; Roco, 2001; The USA National Science and Technology Council, 2004).

According to Roco *et al.* (1999) nanotechnology has been on the political, scientific and educational agenda of at least the United States of America, Europe and Japan. Several initiatives in Australia, Canada, Singapore, China, South Africa, the Philippines, Taiwan, and so on also highlight the international interest in nanotechnology. Simultaneously, nanotechnology has become an interest for industrial and financial sectors all over the globe. The prospect of a large variety of commercial applications in medicine, the energy sector and information technology, has led to heavy investment of large firms in this

technology (Roco *et al.*, 1999; Roco, 2001). In the United States, as reported in Roco *et al.* (1999) and Siegel *et al.* (1998), the USA government and numerous private agencies, such as companies in chemical, computer and other areas, increase their funding for research in support of nanotechnology (e.g., nanoscale devices) to yield new paradigms for computing and data storage, cancer detection and therapy, novel DNA sequencing technologies, and early detection and treatment of heart, lung and blood diseases. Similarly, Japan, the United Kingdom, Canada, Australia, Germany and so on have also accelerated funding for research in support of nanotechnology (Roco *et al.*, 1999).

Smaller and poorer developing countries such as Thailand and the Philippines are both devoting a portion of their small science and technology budgets to nanoscience and nanotechnology (Hassan, 2005). In Sub-Saharan Africa, with the exception of South Africa, the response to nanotechnology is still very slow. As cited in Hassan (2005), Isoun (2005), noted that 'developing countries will not catch up with developed countries by investing in existing technologies alone. In order to compete successfully in global science today, a portion of the science and technology budget of every country must focus on cutting edge science and technologies' (Hassan, 2005).

The South African government through its Department of Science and Technology and with partners in the National system of innovation, upon seeing the long term potential benefits of Nanotechnology, has in December 2005 developed in the National Nanotechnology Strategy (Department of Science and Technology, 2005). The strategy is aimed to 'ensure that South Africa is ready to optimally use Nanotechnology to enhance its global competitiveness and sustainable economic growth' (The National Nanotechnology Strategy, 2005). It also addresses the need to create opportunities for human capital development, particularly for historically disadvantaged individuals, women and people with disabilities. It would also accelerate research and development, stimulate innovation, education, training, curriculum development, improve opportunities for black economy empowerment (BEE) and create transparency, public awareness and acceptance of Nanotechnology (Department of Science and Technology, 2005).

Based on this issue, Martinez-Fernandez and Leevers (2004) perceive the complementary role between university and industry in the field of nanotechnology. They stated that, besides the traditional role of the university to contribute to science and technology, they should be a credible partner to industry. Similarly, Clark (1998) argues that for a university to be considered an ambassador of new technology, there is a need for university–industrial partnerships. Gibbons *et al.* (1994) also argue along this line. They also identify the need for the University to become open, porous and aggressive in seeking partnerships with other knowledge producers for it to play a successful role in producing new knowledge. Uddin and Chowdhury (2001) argued that higher education institutions are not providing enough educational opportunities for the emerging field of nanotechnology. For instance, they report that only a small number of universities in the USA, Europe, Australia and Japan currently offer selective undergraduate programmes in nanoscience and nanotechnology in collaboration with research institute and industries.

This article will review the following issues raised regarding the role of the university in the field of nanotechnology: globalization and the changing role of the university, university–industrial-partnerships, university and government collaboration and modes of training, and as they apply to the case of Wits.

GLOBALIZATION AND THE CHANGING ROLE OF THE UNIVERSITY GLOBALIZATION

Globalization, according to Tickly (2001), lacks a precise definition. However, Held *et al.* (1999) attempted to define globalization as 'a process or set of processes which embodies a transformation in the spatial organizational of social relations and transaction—assessed in impact-generating transcontinental or interregional flows and networks of activity, interaction, and the exercise of power'. According to Held *et al.* (1999), 'flows' refer to the movements of physical artefacts, people, symbols, tokens and information across space and time, whilst 'networks' is used to refer to regularized or patterned interactions between independent agents, nodes of activity or sites of power.

Held *et al.*'s (1999) definitions and understanding of globalization give an insight into the transformative perspective, which is based on the understanding of globalization as a set of processes rather than a single condition. This process involves an interaction and network within the political, military, economic and cultural domains, as well as those of uneven rather than linear relationships (Tickly, 2001).

Similarly, Subotzky (1999) defines globalization as the 'process of intensified transnational economic and social relations leading to complex-economic changes, has had a profound impact on both business and higher education'. Tunnermann-Bernheim and Chaui (2003) argue that the definition of globalization is not confined purely to economic aspects; it is in fact a multidimensional process taking in aspects relating to the economy, finance, science and technology, communications, education, culture and politics. According to them, globalization is inescapable. Globalization and its effect on higher education have been well documented (Gibbons *et al.*, 1994; Currie and Vidovich, 1998; Subotzky, 1999; Clark, 1998; Pearson, 1985; Maasen and Cloete, 2002). Some of the accounts of these writers will be the focus of this section.

Contributing to the debate on the changing role of the university in the context of globalisation, as reported in Maasen and Cloete (2002), Gumport (2000) argued that there is a growing tension between two dominant perspectives on higher education. The first views higher education as a social institution while the second perceives higher education mainly as a part of national economy, in other words, as an industry.

The social institution position states that higher education must attain goals related to its core activities, retain institutional legacies and carry out important functions for the wider society such as the cultivation of citizenships, the reservation of cultural heritage and the formation of skills and the character of students.

The higher education as an 'industry' approach emphasises that higher education institutions sell goods and services, that they train an important part of the workforce and that they foster economic development. It argues that