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## South African Benchmark 2020

Foresight Brief No. 063

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**Sponsors:** Department of Trade and Industry - DTI, <http://www.dti.gov.za>  
**Type:** National foresight exercise  
**Organizer:** Bluepeter Management Consulting, Access Market International (Pty) Ltd  
**Duration:** N/A **Budget:** N/A **Time Horizon:** 2010-2020  
**Publication Date:** 2004

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### Purpose

The overall goal of this foresight study is the identification of global technological trends, which will influence the competitiveness and future development of South African industries over the next 15 years. The study specifically focuses on innovation areas that hold the potential to reduce industrial dependency on foreign technology. Broad-based recommendations are formulated, intending to support the formulation of policies, strategies and programmes aimed at growing South Africa's technology and innovation base.

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### Foresight: A New Instrument for Supporting R&D Decision-making in Post-apartheid South Africa

South Africa is one of the most economically developed countries in Africa and Africa's leader in R&D. Over the past decades, it has developed a vast technological base - mostly on an autarkic basis as a result of the country's isolation during the apartheid era. At that time, the R&D focused on the fields of energy, nuclear technology, mining and armaments industry. South Africa is today still among the world's leaders in the fields of mining, agronomy, medicine, in the production of synthetic fuels and in some branches of the armaments industry. After the transition to democracy in 1994, the former Department of Arts, Culture, Science and Technology (DACST) has initiated measures to reform and modernize South Africa's national innovation system and the science and technology policy has been reoriented.

The study "Towards a Science and Technology Policy for a Democratic South Africa" published in 1993 by the International Development Research Centre recommended the use of technology foresight methods to determine national research priorities. The first national foresight study was initiated in 1998 by the DACST and focused on the following topics: Agriculture, Biodiversity, Crime Prevention, Energy,

Environment, Financial Services, Health, ICT, Manufacturing, Mining and Metallurgy, Tourism and Youth.

The present benchmarking study is the second national foresight study in South Africa, initiated by the Innovation and Technology unit (I&T) of the Enterprises and Industry Development Division (EIDD) at the DTI. This unit provides technology support to industrial sectors with the overall purpose of enhancing industrial sector development.

Starting point of the present study is the insight that an in-depth understanding on global technological developments and the dissemination of such information is the key to long-term competitiveness of South Africa's industries in the global context. The study differs from the first national foresight study that pursued a broad socio-economic approach.

### Macro and Micro level Approaches combined

The study aims at analysing technology trends, benchmarking technologies capable of driving the South African economy and benchmarking South African technology programmes with those provided in other countries. The study, at a macro level, focuses broadly on global technology and sectoral development as well as global technology and innovation promotion developments. The outcome of the macro-level global assessment informs a micro-level per country (or industry sector) assessment including several developed countries (USA, EU countries, Australia) and emerging or



newly industrialized countries (Turkey, Malaysia, Brazil, China, India).

The following industry sectors are covered: ICT, tourism, chemicals, biotechnology, automotive industry, aerospace, metals and minerals, culture, clothing & textile, agro-processing.

For each sector, the study identifies global technology development trends, specific current and emerging technologies and the role of such technologies in sectoral development. Also the relative importance of such technologies in the South African industrial development

landscape - market opportunities, implementation requirements, infrastructure, cross-cutting applications, enabling technologies, etc. - is assessed and specific recommendations for intervention are made based on a SWOT analysis. Furthermore, the study assesses current support offered by governments throughout the world for technology and sectoral promotion, and provides corresponding recommendations on strengthening the role of the South African government, and specifically the DTI in technology and sectoral development. The investigations based primarily on desk research but also included inputs from an international network of associates (per country investigations) and interviews with stakeholders and experts.

## Strategic Technologies identified for the South African industry sectors

### ICT

The following global technology trends were identified:

- **Mobile technologies** - wireless, wearables, Wi-Fi, ultra-wide band, smart phones and location-based services,
- **Smart networked objects** - including technologies like RFID, MEMS, smart dust, digital ink and embedded computing,
- **Semantic technologies** - Semantic Web, XBRL, automatic tagging, affinity profiles and information extraction.

Although South Africa's share of the global ICT market is still small, this sector is deemed to be significant and a growing contributor to economic growth in domestic and export markets. Furthermore, the study considers the ICT sector as an important enabler for other industry sectors.

Of specific importance for the growth and continued development of the South African ICT sector are:

- Mobile technologies and devices,
- Wireless network technologies,
- Human Language Technologies (HLT),
- Open Source Software,
- Telemedicine,
- Geomatics, i.e. the gathering and processing of geographic information or spatially referenced data ,
- Manufacturing Technologies – Robotics / Artificial Intelligence,
- Grid computing,
- RFID.

Especially the mobile technologies, HLT, wireless and OSS technologies are expected to present the most significant opportunities of the South African ICT sector.

### Tourism

The shift of the tourism sector towards a greater emphasis on ICT was identified as a global trend. Although not wholly driven by ICT, the tourism industry needs to use ICT to improve productivity in reaching a broad and diverse customer base. The following technologies were identified as enabling sustainability and further development of the South African tourism sector:

- Mobile technologies enabling e.g. m-commerce, Geographical Information Systems (GIS),
- Wireless technologies,
- Internet,
- Human Languages Technologies (HLT), allowing the bridging of language barriers,
- Environmental technologies - including fuel efficiency, cleaner production processes, renewable resources,
- Cultural Heritage technologies.

The study highlighted the specific role of Internet enabling online transactions and marketing and allowing easier accessibility to information on a global as well as on a national basis. However, Internet was also identified as a potential threat to the South African tourism sector if the infrastructure and network are not improved. Further potential threats are: the lack of skills and knowledge, the perceptions of crime and violence, the environmental degradation, and currency volatility.

### Chemicals

Different development paths are expected depending on the subsector. While specialty chemicals most likely will be significantly influenced by nanoscience and biotechnology in the future, the changes envisaged for basic chemicals (i.e. petrochemicals, bulk polymers and fertilisers) are thought to be based more on evolutionary development than on disruptive innovations. In this evolutionary development, the trend shifts towards cross-linkages between traditional categories of materials. Furthermore, most important global

emerging technologies in the chemicals sector include materials technology, biotechnology and nanotechnology.

The study identified the following key areas with the major potential benefit for the South African chemicals industry:

- Extraction of minerals from coal ash and low value slag,
- Fluorine generation and fluorinated organic chemical intermediates,
- New performance chemicals improving the recovery of minerals in the mining sector such as polymer used in solvent extraction processes,
- Technologies decreasing economies of scale for chemical plants and hence enabling smaller production facilities to compete against the mega plants,
- Low-cost diagnostics and aroma chemicals production,
- Development of biodegradable and high-performance polymers,
- Bio-diesel and products from alpha-olefins,
- Generic pharmaceuticals for meeting future demand for antibiotics and/or anti-retrovirals.

### Biotechnology

The study highlights the fact that South Africa has today only a very small bioeconomy and is still at the R&D level, despite of the widely use of biotechnologies in some industrial sectors including food and beverage, and waste water treatment. Most important areas for further development include the following:

- Recombinant therapeutic products and production of generic medicines,
- Vaccines against important infectious diseases such as HIV/AIDS, TB, malaria, rotavirus and diarrhoea,
- Diagnostics methods used for screening, diagnosis and monitoring or prognosis of diseases by laboratory methodologies,
- Commodity Chemicals from Biomass,
- Energy from Renewable Resources like plant biomass,
- Biocatalysts.

**Functional genomics** - with specific focus on gene expression analysis, **high throughput screening** - based on substantial bioassay development, **bioinformatics** - including biological data management and extraction, **biosafety** and **high throughput genome sequencing** are identified as common to these key areas and therefore deemed to be of highest priority.

### Automotive Industry

Four technologies were highlighted as being critically important for the continuous development and growth of the South African automotive sector:

- Development of lightweight materials,
- Development of alternate fuels e.g. fuel cell technology,
- Sensors, electronics and telematics,
- Improved design and manufacturing processes.

Especially the development of lightweight materials and electronics, sensors and telematics are deemed to be areas

where South Africa can make an impact and possibly, hold a competitive advantage over the rest of the world.

### Aerospace

Six critical technologies for the development and growth of the South African aerospace sector were identified:

- Development of composite materials,
- Development of hyper aero-thermodynamics,
- Development of Sensor usage,
- Health and Usage Monitoring systems,
- Noise Abatement,
- Improved manufacturing processes.

The study highlighted the strengths of the South African aerospace industry as a result of the strategic funding used for military purposes over the last forty years. Important pockets of niche expertise are composite materials and Health and Usage monitoring systems.

### Metals and Minerals Sector

Little major innovation is expected in this sector as it is deemed to be already mature. The current technology trends seem more likely to be incremental improvements in the various value chain processes. Especially in the heavy metals sector innovation mainly concerns aspects like the improved use of gravel as a form of ore, the improved extraction of lower grade ore by developing improved reduction and extraction techniques and the more efficient use of energy. More innovations are expected in the light metals sector, specifically aluminium, magnesium, titanium and the development of alloys with focus on the development of a cheaper, continuous extraction processes for magnesium and titanium.

The study recommends focusing on

- Light materials extraction,
- Alloy technologies, especially in magnesium,
- Process improvement.

### Cultural Sector

The study regards the cultural sector, especially the crafts and tourism industries as a springboard for development with the potential to create jobs and develop less favoured regions. The most important challenges consist in enabling communication technologies, technologies, which improve the product and technologies that provide marketing to the end-consumer.

The following technologies with potential high impact on the Cultural Sector were identified:

- Product Technologies,
- Internet,
- Online Marketing,
- Mobile Technologies,
- Wireless Technologies,

- Advanced Materials,
- Human Language Technologies (HLT),
- E-Commerce,
- Environmental Technologies,
- E-Commerce,
- Portals.

### Clothing & Textile Sector

The following global trends for this sector were identified:

- Increasing use of pervasive and ICT technologies, including internet and wireless technologies at every stage of the production process - telemanufacturing, e-commerce, etc. and in the end products (high performance, intelligent and technical textiles,
- Shift in demand-side away from the undifferentiated mass market towards more differentiated products,
- New technology developments in product traceability and identification guaranteeing quality and protection brand names,
- New value-added natural fibres and synthetic fibres due to technological advancement and therefore needs for higher skilled workers.

The study recommends focusing on:

- Intelligent Textiles,
- High-performance and Technical Textiles,
- Value-Added Natural Fibers - testing systems for foreign fibers in Mohair and wool; yarn formation; dyeing and finishing technologies,
- ICT for product and process improvement.

Processing of plant fibres - a growing market globally - is deemed as a potential critical niche market that South Africa is in an opportunistic position to exploit.

### Agro-Processing Sector

The identified important global research and technological developments for the agro-processing sector are the following:

- Real-time detection of micro organisms in food,
- Sensors for online, real-time control and monitoring of food processing,
- DNA / RNA chip technologies to speed detection and analysis of toxins in foods,
- Food pathogen sensors,
- Separation modules that force molecules into confined environments,
- Real-time detection systems for verification and validation of intervention technologies used in Hazard Analysis and Critical Control Points (HACCP) systems,
- Better understanding of tolerable intake levels for nutraceuticals / dietary supplement components,
- Techniques to inactivate micro organisms to yield safer foods with extended shelf lives,
- Standardized edible food packaging films,
- Biological (e.g., bacteriocins) and chemical inhibitors to prevent or slow growth of pathogens in food,
- Technologies for food traceability.

Amongst the most critical for South Africa are technologies to enable food traceability and technologies to minimize food wastage.

### Policy Impact

The primary purpose of this study was to inform and provide direction for further investigation and discussion and therefore not to set specific recommendations or strategies to be pursued with regards to investment or support for the development of specific technologies. However, the tourism sector, identified in the study as a springboard for South African development, belongs - besides the Business Process Outsourcing Sector - to the top priorities of the Accelerated and Shared Growth

Initiative of South Africa (ASGISA) recently launched by the Government. This initiative aims at halving poverty and unemployment by 2014 by improving the economy's performance and job-creating capacity. Further priority sectors of the ASGISA, also highlighted in the benchmarking study, are the agriculture and agro processing field, including biofuels, followed by the Chemicals sector, the Metals sector, the Creative industries (crafts, film & TV, content and music) and the Clothing and textiles sector.

### Sources & References

The South African study "Benchmarking of Technology Trends and Technology Developments" is available at: [http://www.thedti.gov.za/ERPC/New/DocMgmt/Divisional/EIDD%20\(Enterprise%20and%20Industry%20Development%20Division\)/Technology%20development%20trends%20v0%209\\_PK\\_-RevNo2.pdf](http://www.thedti.gov.za/ERPC/New/DocMgmt/Divisional/EIDD%20(Enterprise%20and%20Industry%20Development%20Division)/Technology%20development%20trends%20v0%209_PK_-RevNo2.pdf)

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