

INNOVATION FOR ECONOMIC GROWTH: THE CASE FOR A WORLD CLASS TOOLING INDUSTRY

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ABSTRACT

A key lever for unlocking the economic potential of any nation is a competitive tooling industry. Like other sectors of the South African economy, the tooling industry has experienced a marked decline in the skills base and requisite expertise needed in a globalised economy. Furthermore, over the past few years, there have been low levels of capital investment among tooling companies in South Africa to keep pace with global trends. This paper will highlight the Department of Science and Technology's (DST) response to the unacceptable decline in the competitiveness and innovative capacity of the tooling Industry in the country. Through the Tshumisano Trust, its implementation agency, the DST has launched three Institutes for Advanced Tooling (IATs) over the past year. These institutes are meant to stimulate the development of innovative products, processes and services through tooling to accelerate economic growth in South Africa. The potential impact of IATs on high growth and innovation-driven industries such as automotives and chemicals will be discussed.

Key words: Innovation, Tooling industry, Economic growth

1. INTRODUCTION

A key input in successful industrialised countries is world class manufacturing to produce high quality goods and services for the global market. Underpinning this manufacturing prowess are the tool, die and moulds industries whose outputs in terms of skills and technology development determine the competitiveness of these countries in the global economy. Like other sectors of the South African economy, the tooling industry has experienced a marked decline in the skills base and requisite expertise needed in a globalised economy. Specifically, highly trained toolmakers and designers have had an immeasurable impact the competitiveness of manufacturing industries of countries such as India (Tool Rooms in India, 1998). Furthermore, over the past few years, there has been a low level of capital investment among tooling companies in South Africa to keep pace with global trends.

Of specific importance to South Africa is the dearth of requisite skills in the tool, die and moulds (TDM) industry. This has resulted in South Africa lagging behind in terms of technology and innovation trends in this critical Industry (Fridge, 2005). As a national response, the Department of Trade and Industry (DTI) in South Africa spearheaded the National Tooling Initiative (NTI). The NTI's core mandate is to rehabilitate the fragmented and technologically aged

tooling industry in South Africa (Van der Merwe, 2007). In collaboration with the Toolmakers Association of South Africa (TASA), the DTI identified the need to close the glaring gaps in skills and technology in the tooling industry. The NTI seeks to bring together government, academics, industry and other stakeholders to develop a comprehensive national strategy to curtail the loss of skills and declining national competitiveness.

Due to the diverse inputs from the industry, other government departments were also called upon to contribute resources and expertise to this initiative. The DTI first commissioned a highly cited study into the industry (See Fridge, 2005). The aim of this study was to highlight challenges in the industry and suggest possible solutions to the skills and technology dilemma facing the South African tooling industry.

This paper will highlight the Department of Science and Technology's (DST) response to the unacceptable decline in the competitiveness and innovative capacity of the tooling industry in the country, in line with the NTI. Through the Tshumisano Trust, its implementation agency, the DST has launched three Institutes for Advanced Tooling (IATs) over the past year. These institutes are meant to stimulate the development of innovative products, processes and services through tooling to accelerate economic growth in South Africa. The potential impact of IATs on high growth and innovation driven industries such as automotives and chemicals is discussed.

2. TOOLING AND ITS CENTRALITY TO ECONOMIC GROWTH

As illustrated in Figure 1, the tool, dye and moulds (TDM) industry touches every aspect of the global economy. From mining to automotives, a vibrant tool industry is a critical contributor to sustainable growth and development. The global TDM sector was estimated at US\$ 22 billion while the local industry was valued at around US\$ 0.47 billion in 2004 (see <http://www.aidc.co.za/index>). The international TDM industry is quite probably larger than official reports actually state. With growing global manufacturing outputs driven in part by the introduction of new and innovative designs of high value consumer products such as motor vehicles, there is no doubt that the tooling industry will continue to grow at an exponential rate.

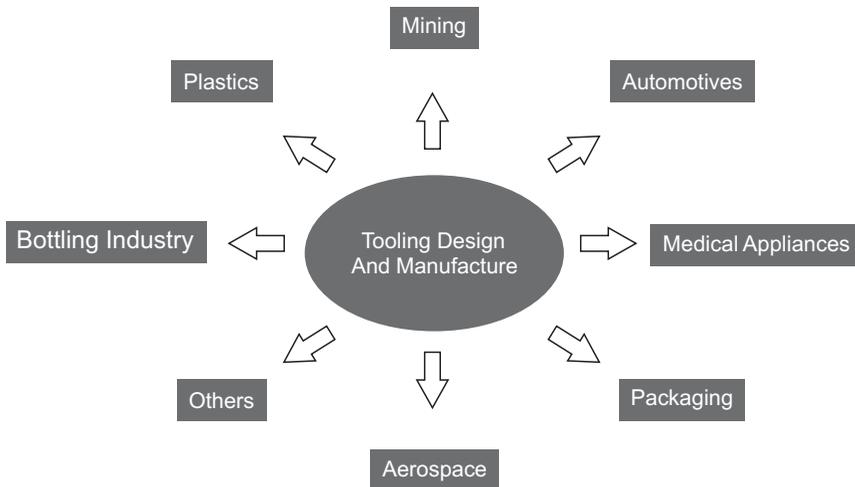


Figure 1: Centrality of tooling to the economy.

The cross-cutting nature of the TDM industry holds the key to the development of the knowledge base needed to fast track the growth of key sectors of the South African economy in that it constitutes as key element in the development of the knowledge base in South Africa to allow economic growth in various sectors of the economy by addressing the failing local markets. Tooling also plays an important role in import substitution through value adding initiatives and quality product enhancement leading to a more positive balance of payments for the country.

However, South Africa is in the midst of a skills crunch especially in critical areas such as designers, IT specialists, project managers and toolmakers who are in short supply and cannot capitalise on this globally lucrative industry. As noted above, there have also been very low levels of investment in cutting-edge technology as compared to efforts in other emerging countries. The negative impact on the broader economy is the fact that South Africa is a net importer of tools, with the local automotive industry importing over R3 billion worth of tools annually (see National Tooling Initiative as discussed in www.aidc.co.za/index).

It is widely believed that a revived tooling industry could also act as a major catalyst for Black Economic Empowerment and Transformation in the manufacturing industry. The availability of raw materials, coupled with the need to create jobs, points to a need for interventions aimed at developing

and supporting the manufacturing sector through beneficiation, which in turn relies heavily on high quality tools.

3. SOUTH AFRICAN GOVERNMENT'S RESPONSE TO THE TOOLING CRISIS

3.1 The Department of Trade and Industry

In response to the tooling crisis, the Department of Trade and Industry in South Africa spearheaded the public-private partnership called the National Tooling Initiative (NTI) which aimed at rehabilitating and growing the South African TDM industry. The NTI core mandate is to turn the TDM industry around by 2014, with the goal of facilitating its evolution from being a net importer to a net exporter of high value tooling products (Le Roux, 2006).

The NTI's five major driving programmes are *skills and expertise development; capacity expansion; small and medium enterprise (SME) and broad-based black economic empowerment structuring; technology recapitalisation; competitiveness improvement and export development* and *public private partnership (PPP) governance structure development*. It is also hoped that the intervention would boost the number of employees in the industry to over eighteen thousand by 2014, thereby supporting an estimated three hundred and seventy-five thousand downstream jobs. The industry currently directly employs about three thousand employees and supports over seventy-five thousand downstream jobs.

From data obtained through the tooling industry survey on tooling, steel material volumes purchased, conversion rates, and turnover levels, as well as information on material volumes and prices supplied to the industry, it is estimated that the average value-added conversion multiplier for the South African tooling industry is approximately 19 or 1,900%. This is a relatively high level of value-added, especially in the metals conversion sector, and is indicative of the technology and skills levels required in the tool making process.

3.2 Department of Science and Technology Input

The Department of Science and Technology (DST) approached the issue of Tooling in South Africa on two fronts: skills development and technology transfer via the setting up of Institutes for Advanced Tooling (IATs) at three universities across the country. The department also established a key agreement with the Indo-German Tool Rooms in India. With this agreement in place, the DST, in collaboration with and funding from the Manufacturing Sector Education & Training Authority (Merseta) and the Western Cape Provincial Government send twenty-nine students for one year's intensive training at one of the Indo-German Tool Rooms (IGTR) in the Indian city of Aurangabad (Martin Creamer, 2005).

3.3 Indo German Tool Room Training for South African Graduates

This tailor-made programme equipped South African Mechanical Engineering graduates with the latest international best practice and techniques of tool design and manufacturing in all areas of tool and die technology. This training was inclusive of real life tooling production environment using state of the art equipment from Germany, Switzerland, Korea, Taiwan and other leading tool making countries.

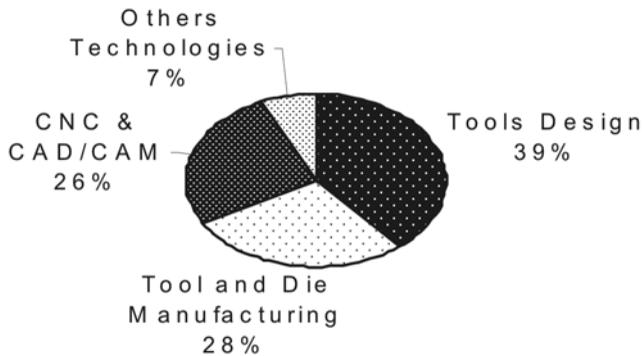


Figure 2: Breakdown of training programme for students at the Indo-German Tool Room in India.

The practical component of the training was done in production layout tool rooms inclusive of the semi-automated conventional tool room machineries to permit a dual training system “*Doing & Doing while Learning*” to maintain desired industry quality standards.

The Indo-German Tool Rooms were established in India via the support of the governments of Germany and Denmark as well as the United Nations Development Programme [UNDP] over thirty years ago. There are over fifteen such tool rooms in twelve states in India primarily servicing SMMEs in the metal and plastics processing industries (Tool Rooms in India, 1998). The key mandate for these tool rooms is two-fold: production and related technical services as well as skills development.

The initial IGTRP corporations’ venture was aimed at training future South African trainers for an envisaged tool training centre, as per memoranda of agreement with joint consortium of funding organisations by the Department of Science and Technology, the Provincial Government of the Western Cape and the MERSETA. Figure 3 illustrates the envisaged deployment of the Indian trained engineers in South Africa.

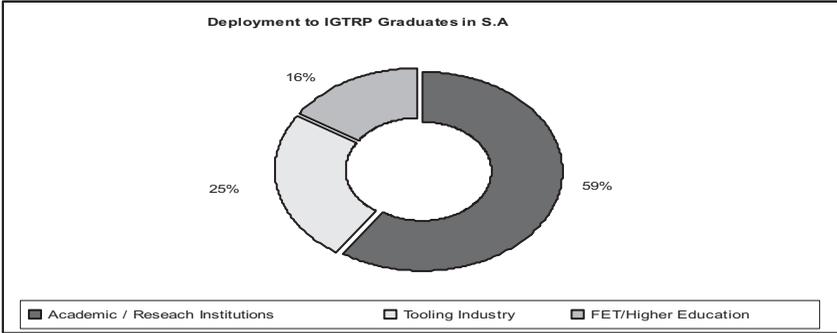


Figure 3: Breakdown of deployment of IGTR trained graduates in South Africa.

The larger percentage of the newly trained tooling engineers forms the core capacity of the Institutes for Advance Tooling (IAT), the centres of excellence for Tooling Technology Transfer, Research and Innovation (see later). The rest of the tooling engineers were deployed either in selected tool rooms in the country or in the Further Education and Training (FET) colleges where they are expected to play a critical role in the national FET College Recapitalization Programmes driven by the Department of Education (DOE) (see <http://www.skillsportal.co.za/fet/302622.htm>).

4. ESTABLISHMENT OF THE INSTITUTES FOR ADVANCED TOOLING

Through its implementation agency, The Tshumisano Trust, The DST launched three IATs at three national universities namely, Tshwane University of Technology, Walter Sisulu and Stellenbosch Universities, towards a national effort to build the innovation capacity of the tooling Industry. With the some of the Indian trained graduates deployed as tooling engineers and lecturers, the DST launched and equipped these three centres through the Trust. The IATs are focusing on technology transfer and skills development to enhance the competitiveness of SMMEs, without necessarily competing with existing tool rooms.

It was envisaged that by equipping the IATs with high end equipment and infrastructure they would be enabled to develop new cutting edge technologies for the local tooling industry. The IATs are also positioned to act as catalysts for transformation in this industry in line with black economic empowerment legislative imperatives through targeted technology transfer initiatives, innovation and applied research and development for emerging SMMEs among previously disadvantaged individuals.

4.1. Institutes for Advanced Tooling Operational Model

The operational model of the three regional institutions is illustrated in Figure 4. Central to their success is the active involvement and inputs of the tooling industry. The three IATs at Walter Sisulu, Tshwane and Stellenbosch Universities respectively focus on Tool Design , Tooling Technology Transfer , Research and **Innovation** to enhance the competitiveness of the SMMEs in the tooling industry.



Figure 4: Operational Model for the Institutes for Advanced Tooling (IATs).

As mentioned above, the Institutes for Advanced Tooling are also positioned as centres of excellence for skills development and technology transfer diffusions to accelerate the country's growth in tooling sector. The acquisition of appropriate and skilled human resources that can carry out the technical and non-technical operations required is also central to the operations of these Institutes.

4.2. Technological competencies and services at the IATs

4.2.1 Capital Equipment

The IATs are equipped with a range of modern industry-specific capital equipment and technologies. These include:

- modular high precision, 5 axis CNC milling machines;
- metrology equipment including a Coordinate Measuring Machine (CMM) for quality assurance;
- EDM spark erosion, Robo drilling and Wire Cut EDM CNC machinery;
- 3D printer for Rapid Prototyping Technology Platforms for reverse engineering.

4.2.2 Software Capabilities

The IATs are equipped with high-end CAD/CAM software technology for modelling and manufacturing. These include:

- Pro-Engineer Wild Fire III that will be used for 3D CAD;
- mould flow software for polymer behaviour examinations and optimisation;
- MasterCam and AutoCAD 2006;
- Unigraphics and Mold Wizard module of UG;
- Dynaform for Sheet Metal Analysis.

4.3 Tool Design at Walter Sisulu University

The centre is expected to continuously provide quality design of tools in compliance with existing quality standards. All orders relating to tool design and production enhancement will at all times be tackled by tool designers. A broad scope of services in tool design and production planning of press tools, gauges, plastic moulds, jigs and fixtures as well as dies will be analytically executed using simulations, analysis processes and testing from non-conventional manufacturing processes. Furthermore, design of blow moulds, transfer moulds and compression moulds using competent 3D modelling software and finite element methods for structural analysis and sheet metal forming analysis will also undertaken.

4.4 Research, Development and Innovation at University of Stellenbosch

The IAT at the University of Stellenbosch will be specialising in manufacturing of intricate shapes (cores and cavities) generating tool paths for high speed machining processes using CAM software packages. Developing cutting strategies for cost and lead-time reduction, cutting strategies for specific surface finish requirements and surface modification, milling of hard materials (tool steel) as well as manufacturing of fully assembled tooling will be key focus areas of the IAT.

4.5 Technology Transfer at Tshwane University of Technology

The ultimate success of the IAT at the TUT campus in Soshanguve lies in the ability to provide world-class technological tooling solutions for industry and SMMEs with a strong focus on BEE development. It is envisaged that the supported local enterprises will develop and produce innovative products leading to enhanced import substitution.

Also, a production lay-out tool room infrastructure is already in place to provide an environment to train a new generation of toolmakers and designers that have understanding of cutting edge tooling technologies. The activities in this particular centre will complete the innovation value chain and skills demand driven model for technology transfer for SMMEs (Figure 5).

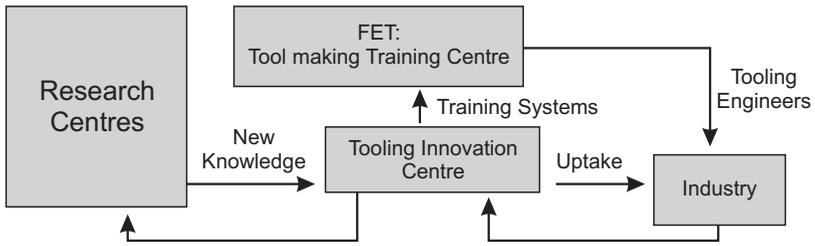


Figure 5: Technology Transfer model for the IATs in Tshwane University of Technology.

These interventions continue to be informed by the real needs of the industry. It is envisaged that as the IATs develop and establish their national footprint, the services will be equally split between skills development and technology transfer and innovation for the tooling SMMEs.

The success of the IATs will also be enhanced by their linkage with the highly successful Technology Station Programme run by the Tshumisano Trust. The TSP has since 2002 focused on assisting SMMEs in all sectors of the South African economy. It is hence envisaged that the IATs will also benefit from the success of its stable-mate to serve and expand its assistance to SMMEs as well as skills enhancement.

Examples of Tooling Solutions for the Industry through the IATs Technology Solutions for Industry

As illustrated in Figure 6, a significant percentage of industry intervention by the IATs is on near market technology solutions such as product testing, design, development as well as manufacturing.

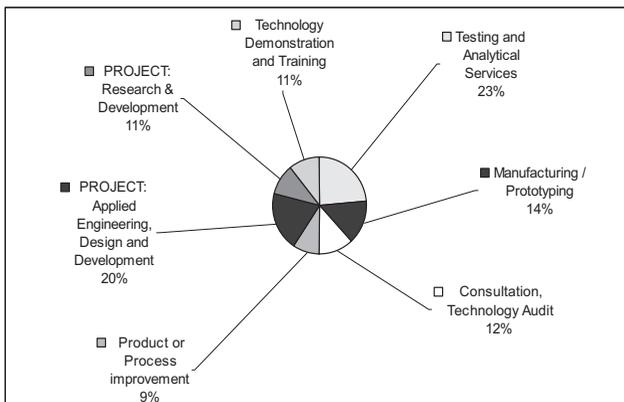


Figure 6: Types of Technology Services provided by the Institutes for Advanced Tooling

This is in not just in line with the Trust's technology diffusion mandate, but the IAT services also highlight the importance of these kinds of interventions for the tooling industry.

5. EXAMPLES OF INDUSTRY INTERVENTIONS AND COLLABORATIONS

5.1 Local Collaborations

The three IATs have partnered as tooling suppliers with the CSIR Materials Science and Manufacturing division in establishing a high pressure die casting facility to cast Thermojet parts. This forms part of national research initiatives in the casting of industrially important super alloys. The project is done in phases, focusing on new equipment installation, tool trials and commissioning at the CSIR facility.

5.2 INTERNATIONAL COOPERATION

Indo-German Tool Room

The IATs have a long-standing international collaboration with the Indo-German Tool Room in the city of Aurangabad in India and its allied/networked companies with production tooling expertise. This cooperation will be maintained in terms of providing training in tool design and manufacturing to enhance the human resources capacity in South Africa. This link also allows access to tool design and manufacturing curricula as well as creation of initiatives of employee exchange programmes. There is a vital need for international links in the South African tooling industries to set up world class manufacturing standards and designs.

Another cutting edge innovation in tool and die manufacture is best reflected in the two EU-funded mega-projects: Euro Tooling 21 (to prepare the European tooling industry for the 21st century) and SPADE (Spare Parts on Demand). In both of these projects, the IAT at Tshwane University of Technology and University of Stellenbosch (GCC) are directly involved via partnership agreements with European consortium members. Key project coordinators are Materialize (Belgium) and Frahofer IPT (Germany).

The Global Competitiveness Centre (GCC) which hosts the IAT at the University of Stellenbosch in the Western Cape has been partnering with Frahofer IPT & RWTH-WZL in Germany since 1998 in a number of projects. In one of those, they have implemented the Aachen Benchmarking Model in a number of South Africa companies. This link enables the IAT to have access to new technological developments in the SPADE project.

Human Resources Development

Private industries have agreed to a mentorship role for tooling interns involved in a pilot for New Venture Creation (NVC) in the IAT at Tshwane University of Technology to ensure that the tooling technologies learned are based on

industrial projects. Discretionary funding from Merseta was secured for the launch of NVC. Interns are receiving formal courses in all aspects of the tooling industry. The NVC is an IAT-driven initiative representing a strategy in establishing new SMEs in a network-centric approach.

Institutional Learning and Development

The IAT at the Tshwane University of Technology in Soshanguve in partnership with a well known global consumer goods company and a local SME called Spec Tool and Die in Durban have a major international breakthrough in utilising Laser Cusing and the Clam methodology, culminating in a 31,31% cycle time reduction in the manufacture of packaging products at the global company.

The IAT in the Western Cape and USABCO & Concept Laser GmbH from Germany are collaborating in a weight (thickness) reduction project to minimise plastic processing and disposal gas emissions.

5.3 Examples of Tooling Industry Interventions by the IATs

A local SME was assisted with product development of a paint ball plastic container and plastic injection moulding tooling to enable it to secure a multi-national contract on this product currently being imported from the United States. The IAT in the Western Cape is also in a collaborative project to design a small hand-operated press tool and machine to produce dog tags and on-site training of machine operators.

Another key project undertaken by one of the IATs was in the design, testing and manufacturing of pall rings, a key input for distillation columns in the petrochemical industry. The Middleburg Stainless Initiative (MSI) is an entrepreneur incubator that supports emerging businesses involved in stainless steel product fabrication for the local industry. The demand in South Africa for pall rings is valued at well over ten million rands due to the presence of world scale petrochemical processing companies. The aim of this project is two-fold: firstly, to capture the market from foreign competitors via import substitution. Secondly, to create opportunities for new SMEs which would hopefully lead to job creation opportunities in Mpumalanga, one of the poorest provinces in the country. The IAT is currently doing the research and development of a fully automated press tooling for the production of the pall rings.

6. CONCLUSION

The paper serves to highlight the challenges faced by South Africa in a critical sector of the economy. With ever-increasing competitive pressures from low cost countries, government initiatives in this regard are timely. The national tooling initiatives and institutions such as the IATs can go a long way in curtailing the decline of the tooling industry in South Africa. The success of these interventions is underpinned by active cooperation between all relevant government departments and agencies involved in this space. This includes

but is not restricted to the Department of Trade and Industry (Policy), Department of Science and Technology (Technology and Innovation) and Departments of Education and Labour (Training and Skills Development).

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