EXECUTIVE SUMMARY

The South African Tool, Die and Mould (TDM) Industry is in a process of re-inventing itself to take advantage of growth in the industry globally and domestically. The FRIDGE has commissioned this study in order to thoroughly assess the nature of the TDM industry in South Africa and globally, and, based on this evidence, to develop a strategic action plan for the industry.

The research has found that the South African TDM industry is not currently well positioned to take advantage of the growth opportunities available to it but that it has the possibility of adapting efficiently and effectively if an Industry Master Plan is adopted by all stakeholders and implemented thoroughly over the next ten years.

The TDM industry is a hi-tech Industry, which require the development of specialized skills to support any new investment and re capitalization process in the industry, due to the requirement of the most sophisticated and exacting skills in any manufacturing process.

The rejuvenation of the TDM industry in South Africa is, according to the research findings, both desirable and possible. It is desirable because the industry is strategically critical for South African manufacturing as an underpinning industry. Every manufacturer in South and Southern Africa needs tools, dies or moulds in order to manufacture. To the extent that these can be supplied competitively locally, this improves the competitive capability of all South African industry across the board. Equally, the industry is relatively labour intensive, and requires skills at all levels. Even if the industry did not grow, some action would be required to prevent job losses. Since many of the TDMs in South Africa are small enterprises, job creation potential is high and barriers to entry at the lower tech levels are relatively low. Finally, the TDM process is an extremely high value added process. Even though the raw materials are largely imported, such substantial value is added that from a value add point of view, it is a desirable industry to support.

The research has concluded that it is possible to rejuvenate the TDM industry in South Africa, in spite of extensive global competition from low priced and high tech competitors. This is because South Africa is a net importer of TDMs (most of which could be made locally) and may have some competitive advantages with particular niche products (rock drilling), which have been inadequately exploited to date. Additionally, the presence of the global automotive industry and a substantial domestic packaging industry suggest that a base load of work is available to the industry during the process of rejuvenation. This is not the case for many South African industries and this means that the TDMs begin the improvement process with some level of commercial support. TDM industries around the world are also supported by their governments in developing ever improved competitive capability. It must be pointed out that without government support, it will be substantially more difficult for the South African TDM industry to improve its economic performance.

Until recently, the TDM industry had little structure and no master plan. This has changed with the recent advent of the Toolmakers Association of South Africa (TASA) and the institutional structure required to implement a ten-year master plan is in place and functions well. Key challenges relate to skills development, the attraction of new recruits to the industry and the replacement of an old technology base. However, these issues can be effectively addressed if all stakeholders work together. It is therefore recommended that the TDM industry works within a support package specifically focused on the TDM industry but developed from the existing support base.

Global Tool Die & Mould (TDM)

The global TDM sector was valued at US$ 22 billion in 2004. The International TDM industry is quite probably larger than official reports actually state. With growing world markets and the more frequent introduction of new designs of consumer products, the demand for new tools, dies and moulds (TDMs) will continue to increase. Tool manufactures vary in size from one-man operations up to global enterprises but most reports indicate that 80% of tool making companies around the world are SMEs. The industry overall relies heavily on overtime as a strategy for dealing with periods of higher workloads. In Korea and Malaysia, actual hours worked in 2003 averaged approximately 130% of normal working hours per annum, while in the developed economies actual hours worked were lower than normal hours. Wages and salaries vary enormously- although India and China did not report theirs. As the following table indicates, Switzerland, followed by the US and the UK, pay the highest hourly rate for mould makers and skilled tool and die makers (in Euros) while Estonia, Korea and Portugal pay the lowest rates. Chinese and Indian rates are lower.

The global industry is growing internationally at approximately 9% per annum although there are regional variations – there is very high growth in China and lower growth in developed economies. Germany had the highest sales in US$ terms followed by the USA and then Japan - 61% of all industry turnover. Canada, Italy, Malaysia and Spain form the second tier and together made up approximately 28% of industry turnover. Of the third tier suppliers, the UK, Australia, Portugal and Switzerland dominate. Germany is the largest exporter, (in value terms) followed by Canada and the US. Canada exports virtually all of its production to the US. Germany and the US both generate approximately 20% of their total turnover from exports. The US is the largest importer of Moulds, Tools and Dies followed by Malaysia. Both countries import substantially more than they export, while Germany, Canada and Japan are net exporters.

The overriding factor in the mould and die industry today is its global nature. There are buyers of moulds and dies all over the world. There are producers of moulds and dies all over the world. One effect of globalization is that most of the simpler, lower tolerance mould and die work has moved to developing countries where labour rates are low and the technology relatively undemanding. The bulk of mould and die building that has remained in the United States, Europe and Japan is the high tolerance, highly engineered work although China cannot be disregarded in terms of its move into this arena.

Shrinking domestic markets in the developed world and increased costs as well as the volatility of input costs such as steel and other metals are negative trends which drive the developed world to seek new markets. Input costs consist primarily of personnel, input materials (mostly metals) and the purchase of new equipment to improve productivity and quality. There are highly cyclical demand conditions and consequently the industry continuously has to deal with capacity and capacity utilization issues. Over capacity in the developed countries is a result of a shrinking domestic markets and the availability of less expensive imports from other countries, typically the less developed where personnel costs are lower. Finally, when there is a downturn in the developed economies, demand for goods drops and so too, does demand for moulds, tools and dies.

Price is a leading factor of competition around the world. Developing country producers usually have a significant advantage in price. *Delivery time and product quality* are typically the next most important competitive factors – and this often translates, from a quality point of view, into quality management capability and ranking and design expertise. Highly competitive pricing conditions have driven manufacturers of consumer goods in the developed countries to rationalize all aspects of production, including the procurement of TDMs, with resultant downward pricing pressure on tooling producers. This pressure has been especially significant for moulds used in sectors such as automotive, household appliances, power hand tools, house ware, and electronics.

Technological advances within the tooling industry have significantly improved productivity and competitiveness, while increasing capacity and ameliorating the need for highly skilled labour. Because advanced TDM production technology is universally available, increased productivity is occurring simultaneously in both formerly industrialized and newly industrializing regions. Despite the significant capital equipment used in this industry labour costs are the largest single component of production costs for developed country TDM producers and a significant component of production costs for all producers except in economies where wages are controlled. For example, Chinese hourly compensation costs for toolmakers and tool designers are one-twelfth of those in the U.S., and those in Taiwan are one-third.

Factory overhead costs for many developed country TDM producers are high compared with competitors. This is in part the result of firms operating at less than full capacity because of weak business conditions and intense competition. Many Chinese firms operate 24 hours a day, 7 days a week, thus more fully utilizing their machinery. With regard to material costs prices are believed to be approximately the same. However, steels that are more widely available may vary significantly in price in different national markets, and the scale of purchases may introduce pricing differentials for all materials among TDM producers.

Tariff protection varies but a trend of lower tariffs applied in developed countries and higher tariffs applied in developing countries can be seen, especially between the EU, the US and Asia. Many U.S. tariffs on TDMs are free, with tariffs on dies ranging from 2.9% ad valorem to 5.7% ad valorem and on moulds from free to 3.8% ad valorem. Like the U.S., EU tariffs are relatively low (ranging from free to 5% ad valorem), however, tariffs in China (ranging from free to 19% ad valorem) and Taiwan (ranging from free to 11.5% ad valorem) are relatively high. Finally, exchange rates can significantly limit a producer's ability to obtain business in foreign markets.

There are major technology trends emerging in the global TDM sector- and South Africa will need to invest heavily in the necessary technology in order to stay competitive. These are:

- *Compression :* Demand from customers for faster delivery of completed projects is another major issue. Many mould and die buyers are willing to award substantial premiums to the supplier who can deliver a week or two earlier than other shops bidding on the job. Companies have managed to achieve these time savings by speeding up processes, by performing steps simultaneously, and by minimizing or eliminating steps. It appears that many die and mould shops are justifying capital equipment purchases on this basis.
- *High Speed Machining :* High speed machining is probably the most significant technological impact on die/mould machining. High speed machining allows certain trade-offs to be made,

and these trade-offs can be manipulated to advantage. One of these trade-offs is between time on the milling machine and time on the polishing bench.

- Eliminating operations is also the goal for finishing passes at high speed, but in this case, operations after machining are the ones to be eliminated or reduced.
- *Hard Milling :* Another process shift that high speed machining opens up is machining mould and die cavities in fully hardened materials. This has been especially valuable for forging dies, which usually require higher hardness than other types of moulds and dies. Both roughing and finishing are performed as one continuous process on the same machine. In concept, high spindle speeds and small diameter tools in light cuts create sufficient torque to machine materials as hard as 64 Rc. Fine finishes are achieved with small stepovers in the finishing passes.
- *CAD/CAM :* Probably the three biggest developments in CAD/CAM for the world's toolmakers right now are *hybrid modelling, knowledge-based* design and manufacturing systems and *shopfloor 3D programming*. These issues are becoming highly interrelated in the on-going debate over how and where NC programming is best accomplished.
- *Knowledge-Based Systems :* CAD/CAM technology has finally arrived at the point where standard design features can be recognized automatically in CAM (a capability referred to as "automatic feature recognition") and associated with a pre-planned manufacturing process. CAM systems are being developed in Germany with the capability to analyze a sculpted 3D form and to automatically suggest appropriate machining strategies for different portions of the model. An early example of this type of functionality is "slope machining," which detects and creates boundaries around surfaces that are steeper than a given limit angle. This capability allows the CAM system to machine the flat and steep areas of a model with the most appropriate machining strategies, without having to draw boundaries manually.
- *Shop Floor Programming :* Many shops initially tried programming in the shop during the last 20 years but given the historical complexities of creating 3D tool paths, most moved it to the more controlled environment of the CAD/CAM room. As tooling has grown increasingly more complicated NC programming has become a predominant bottleneck across the industry. Moving programming back to the shop is increasingly relieving that limitation, made practical by the advent of extremely easy-to-use programming tools. There is a strong trend toward shop floor programming in Europe, especially in the auto industry, mainly driven by pressures to reduce cost and time.
- *Metrology , Quality awareness and Inspection*: South African TDMS traditionally manufacture tools to a toolmakers specification without regard for the dimensional accuracy of the component. Due to the stringent requirements of Automation in assembly and handling of components the precise verification of dimensional requirements in the manufacture of tooling has become an essential part of the process in final inspection as well as inter-operational verification against CAD designs. The knowledge base is Hi-Tech as it requires an integration between ICT knowledge based systems such as CAD 3D Surface Models and sophisticated 3D CMM (3D Co-Ordinate Measuring Machine) verification and comparison Software. These skills are extremely rare in the SA skills value chain and require specialist training as there is no curriculum developed for training in the SA educational system. Courses offered are extremely limited and are offered only as part of further advanced education by few Accademic Universities with insufficient depth. Refer to Stellenbosch University GCC (Prof.D Dimitrof) for further reference and DST's IAT Institute for advanced tooling proposal.(Nawaaz Mohamed)

- ***Project Engineering:*** Project engineering and the required skills, are critical to the tool making process.

- ***Robotics:*** Robotic loading and unloading of machines is the next level of automation that many mould shops are rising to. System 3R, best known for its pioneering integrated tooling systems for EDM, saw more mould shops purchase its Workman robotic systems for mills and EDMs last year than in the three previous years combined. Automation allows increased productivity level to be inherent to the process and not the operator. Automation is a strong theme in the machining of dies for stamping or forming sheet metal in Europe. There is a clear trend to high speed machines with automatic pallet changers and automatic head changers (but no automatic tool changer). One important change is that both ram and wire machines are considerably faster than they were only a few years ago.

The standards for most tools are set by the customers. Toolmakers, in general, will have experience of supplying a particular industry. If the customer does not have a specification, it it is left to the toolmakers judgment and they will supply the normal standard for that industry. The automotive and similar industry customers will have comprehensive standards which they will have developed themselves and which they will negotiate with their suppliers. Accreditation to National standards such as ISO 9000 will often be a requirement for smaller customers but the automotive industry has now set it's own standards, based on ISO 9000 but going a lot further.

South African TDM

The value of the South African TDM industry over the same period was US$ 0.49 billion (ZAR 3,3 billion) with imports of ZAR 1,25 million and exports of ZAR 400 million, resulting in a negative trade balance of ZAR 800 million. GDP/Employee in this industry is high for a manufacturing industry at ZAR 862,000 and value added along the value chain is much higher even than in the automotive industry at 1,900%

The TDM industry represents 1% of manufacturing GDP and consists of geographically clustered groupings across South Africa, typically located close to the major customers in the Packaging and Automotive industries. There are 240 tool rooms in South Africa, of which 30 are considered captive (part of a larger manufacturing operation). Of the 240 tool rooms, only 20 can be considered large- the remainder, as is the case internationally, are SMMEs. The industry employs 2,900 (e) directly and is an industry where high levels of skills are required – of 20 employees, 17 can be considered relatively highly skilled.

Domestic demand is high and relatively stable due to a strong packaging industry in South Africa. In fact, the local industry cannot meet demand and as a result there is a high level of imports. The automotive and packaging sectors represent 90% of current demand for TDMs in South Africa, with the white goods, aerospace, and medical and precision equipment making up the remainder. However, during the next 20 years, 40% of current aircraft will be retired which, when combined with the governments announced intention to develop the South African Aerospace sector, represents future opportunities for the sector. Additionally, the medical equipment industry worldwide is worth $130 billion- and South Africa does not participate in this sector in any meaningful way.

The South African TDM industry at it stands today is working significantly below capacity and equipment is ageing. There are limited exports (R100 million of an estimated R1.4 Billion) and large local customers often import requirements. The trade gap is growing – in 2001 the trade deficit was R848 million and in 2002, it was R1.2 billion in the automotive sector alone. Most estimates suggest that there is R 4 billion worth of imports available for import replacement should the TDMs gear up. For every R 1 million invested in TDM equipment and technology, over R250 million of components could be produced, making the industry a high value added catalyst in the South African economy. The South African tooling industry has only grown by about 10% per annum of late. In real terms this is actually negative growth due to:

- the devaluation of the Rand,
- the erosion of the skills base
- the competition from the Global competitors
- The lack of investment in capital equipment and associated ICT systems in the Tooling Industry since 1983.

South Africa's production costs are significantly higher than its competitors as low levels of investment over time in the necessary technology have resulted in South Africans working with ageing technology/equipment and inefficient work methods as compared to competitor nations, even though competitive technology is available through linkages with technology institutions. One reason for low investment levels is as a consequence of poor profitability - the moulds, tools and dies produced for the South African market must often cater for much lower production runs compared to their international counterparts and this results in South African tool rooms often supplying lower quality, lower priced tooling solutions. Locked in this vicious cycle, the tool rooms are only able to recover minimum profits and then do not have the funds to invest in proper operational systems, training of personnel and equipment to render themselves more competitive and profitable over time.

There is a real shortage of skilled workers in the area of tool and die manufacturing and design, at all levels. Basic training and skills development systems do not exist or are below standard. Major shortages are:

- Tool makers
- CNC programmers
- Designers
- Estimators
- Metrologists and Inspectors
- Project Managers

The survey undertaken by Blueprint indicated that existing skills lost to South Africa arise primarily from young white males who leave the country to seek better opportunities overseas as there is a worldwide shortage of tool-makers and tool designers. Most leave for Canada, the UK and Australia- essentially, English speaking countries where opportunities exist. Most toolmakers believe that it takes 5-6 years to develop a competent tool maker (70%) with 22% indicating that over 6 years is required and 8% indicating that 3-4 years is sufficient. Sub contracting of overseas personnel is generally not undertaken (92%) although a small percentage use overseas skills occasionally- the

main reason for such limited use of overseas skills is the cost. Other barriers to the use of offshore skills cited were language, relocation costs, lack of ability to recruit and inability to test competency. Respondents indicated that technology shifts in the industry have increased the need in South Africa for higher order skills (outlined in the international section of this interim report) such as CNC operators and estimators.

The most outsourced skill at the moment in the South African TDM industry is tool design. In South Africa, availability is also an issue. Finally, temporary labour is used during periods of high production activity, and some tool rooms share labour. The majority of employees (60%) have skills in more than one area, according to respondents and are able to multi-task to some degree- essential since there are skills shortages.

South Africa's average Toolmaker wage of R85/hr (2003) compared with leading tool export countries puts it higher than Korea (Eu5/h) but in the same range as Portugal (Eu11/hr). The gap has closed on major export markets since 2001 where South Africa's average toolmaker wage was about 25% of USA's (Eu24/hr), and less than 50% of that of Germany (Eu 14/hr) to a position where it is 70% of Germany's wage and 60% of the USA's rate which dropped to Eu 17/hr from 2001 to 2003 (*ISTMA 2003*). The current average wage is R100/h and expected to rise to R110/h and it is rising more rapidly than competitors or export markets.