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### TOWARDS DEVELOPING A SUSTAINABLE DEVELOPMENT FRAMEWORK FOR THE ALUMINIUM CASTING INDUSTRY

#### ABSTRACT

**Title: Exploring a Sustainable Development Framework for the downstream beneficiation of aluminium via the die casting industry within the context of a developing economy**

The capacity of primary aluminium production is high with the associated high energy consumption and subsequent increase in air pollution. The secondary supply capacity, however, is declining due to an unregulated scrap industry.

South Africa still has relatively cheap labour/energy, good potential, volume markets, i.e. the automotive/domestic/electrical/armaments/aerospace markets, and a very favourable business development and investment environment enabled by government, namely the Motor Industry Development Programme, IDP/BEE/SEDA, etc.

The volume markets, however, are reluctant to source from the local industry, and the industry in its turn is reluctant to supply and grow new markets due to a lack of capex and a Total Quality Management culture. Export markets are also avoided due to the strengthening local currency against the US Dollar. Cheap imports from emerging cast product markets such as China and India is threatening South Africa's competitiveness.'

It is thus not surprising that the aluminium casting output has declined by 21% since 2001 and is still declining (CSIR, 2006:30)

#### **Purpose of the paper**

The paper explores the relevant and realistic SD Indicators, and the implementation of productivity interventions by using these indicators to improve the SD situation and to make South Africa's industry more competitive. These include the following:

Availability of alloys; alloy development; process control; raw material (scrap) pricing; legislative environment; governance; R&D (design, modelling, commercialisation); skills development; tool-making expertise; market development; total quality management; investment; and waste management.

These interventions will therefore accommodate the PESTLE analysis (Political, Economic, Social, Technology, Legislative and Ecological).

The beneficiation of the six forms of 'CAPITAL' (resources)\* is paramount for the sustainability of the manufacturing industry in South Africa, a country which has traditionally been commodity export intensive, which poses limited local sustainability advantages.

\*The idea of 'capital' is a useful concept when discussing sustainable development (MMSD, 2002). This goes beyond the common idea of financial capital and has six forms, according to the Council for Scientific and Industrial Research (CSIR):

- Natural capital
- Manufactured capital
- Human capital
- Social capital
- Political capital
- Financial capital.

#### **1. INTRODUCTION**

South Africa is a minerals/resource/commodity-rich country and has traditionally earned most of its foreign exchange from this sector.

It is also true that traditionally South Africa has not used the opportunities to grow and develop the manufacturing sector (downstream beneficiation) in a sustainable manner. The harnessing of South Africa's mineral resources to value-added metal products provided short-term economically feasible opportunities, but this was unsustainable in the long term due to cheap labour, cheap energy, slack environmental legislation and, at the time, almost non-existent foreign competitors and lenient quality requirements from customers (SADC 1996).

There were other unsustainable enabling factors within the context of a broader unsustainable

political regime, i.e. low cost of capital due to a strong currency, strong government support and protection of the metals manufacturing industry as strategic partners.

All this has changed, and the present manufacturing climate in South Africa is very hostile due, amongst other things, to threats of cheaper imports from the emerging Asian markets, a volatile currency, more demanding labour legislation, empowerment and demographic transformation (black economic empowerment), low skills levels mainly due to the legacy of the previous political dispensation, stricter environmental legislation, more expensive energy, and a drive for better quality and productivity. Ironically, amidst an abundance of metal raw material in South Africa, the prices are uncompetitive for local manufacturers.

*The result is that the industry is unsustainable in its current state. An example to illustrate this situation is the decline in South Africa's aluminium casting production by 21% since 2001, and which is still declining (CSIR, 2006: 30). This is disturbing, since the opportunities for aluminium castings are promising because of the volume-driven markets currently in South Africa, such as the automotive industry.*

## **2. SUSTAINABILITY/SUSTAINABLE DEVELOPMENT**

The concept of *sustainability/sustainable development* is emerging as a crucial driver of change in the industrial realm throughout the world.

Globally, business and industry are starting to take cognisance of the fact that when it comes to resource utilisation it is not "business as usual". A shift is taking place from the so-called 'weak sustainability' to a 'strong sustainability' paradigm. According to Michie et al., (1995), "...*strong sustainable development* says that there are identifiable limits to environmental loss and damage: there are boundaries beyond which we will not allow environmental degradation to go."

In a survey of the Sustainable (environmental) Technology Best Practice Programme in 1998 (BMRB 1998), it was revealed that the larger respondents were doing better in areas of sustainability than they were in 1995. The 1995 survey indicated that business and industry perceived environmental improvements in the course of business as a cost factor only, with no financial benefits. Now, however, a shift in this belief is evident, and indications are strong that a corporate culture of the bottom-line benefits,

associated with improved environmental performance, is emerging. Regulatory pressure, it seems, is no longer the principle driver.

Sustainable development simply means economic and social growth patterns that maintain the integrity of the planet's resource base in a way such that the use of these resources does not outweigh their replenishment, rehabilitation, recovery and substitution potential.

In its broadest sense, "...sustainable development, in theory, means development that meets the needs of the present without compromising the ability of future generations to meet their needs" (UN World Commission on Environment and Development, 1987).

Applying this concept to a sustainable economy "... means that such an economy can continue to develop, not in the old pattern of economic growth, but through improvements in research and development, better business planning, resourcefulness, improved technical/process efficiencies, and innovative economic models (investments) ...it is one which does not exploit this resource base beyond its capacity to regenerate continually" (Munroe & Holdgate, 1991).

Everybody has an impact on the Earth, because they (through industry) consume the products and services of nature. The metals industry in particular has a large economic, social and ecological impact on the biophysical environment. Compare Wackernagel's 'ecological footprint' which states: "Everybody has an impact on the Earth, because they consume the products and services of nature. Their ecological impact corresponds to the amount of nature they occupy to keep them going..." (Wackernagel, 1997).

Human activities (industrial) are now changing the environment on an unprecedented scale and in some instances irreversible changes are being made to the planet's natural resource regime with a catastrophic loss of biodiversity. This has become known as a possible 6<sup>th</sup> mass extinction. By persisting in using existing technologies, resulting in the unsustainable use of renewable resources, it will be impossible to realise the Millennium Development Goals, according to Lawton (2005: 120).

It is therefore critical that sustainable development of this industry should be addressed as an integral component of economic growth.

### 3. THE ALUMINIUM CASTING INDUSTRY AND SUSTAINABLE DEVELOPMENT

In a survey conducted by the CSIR (CSIR, 2006), it was revealed that less than 10% of aluminium foundries were ISO 14000 certified, approximately 30% were adhering to a formal Quality Management System, and skills development and marketing were seriously lacking. The utilisation of government incentive schemes was also insufficient.

The reason for the reluctance to address sustainability issues is that short-term planning takes preference over long-term planning strategies. This may be due to a number of possible factors:

- Lack of a spirit of corporate citizenship
- Ecological ignorance
- Lack of environmental awareness/ethics
- Lack of enforcement of regulations/law enforcement
- Lack of environmental compliance due to the perception that environmental compliance is just an expense
- Unawareness of global sustainability requirements for export competitiveness
- Time constraints
- Low margins
- Lack of long-term planning/strategies
- No sense of social responsibility and 'public good'.

### 4. AIM OF THIS PAPER

The aim of this paper is to develop a framework within which the Aluminium Casting Industry can conceptualise a methodology (model) which will assist it to attain long-term sustainability. This will be achieved by analysing the current levels of sustainability of the industry.

The concept of *sustainability* in this context embodies three main dimensions of the environment, namely economic, social and ecological, as depicted in the Van Rooyen Model of the environment (Van Rooyen, 2005).

The application of sustainability auditing within industry and research & development agencies and other stakeholders is of paramount importance in the follow-up research emanating from this study.

A sustainable corporate philosophy is essential to ensure a healthy economic, social and ecological environment and to develop and adopt an

appropriate, dynamic research & development and technology transfer policy.

The cross-cutting sustainability issues, according to the World Business Council for Sustainable Development ([www.wbcsd.ch](http://www.wbcsd.ch)), to be addressed as a secondary aim of the research, are: governance issues, i.e. corporate citizenship, capacity building, (empowering previously disadvantaged individuals, sustainable and fair trade market development), risk management and total quality management.

The objectives of this paper are thus to:

- Determine the current state of sustainability (economic, social and ecological) of the aluminium die casting industry in South Africa and diagnose the shortcomings/strengths in the sustainability paradigm of this manufacturing sector.
- Identify and unpack the Sustainability Indicators for the industry.

### 5. THE CURRENT SITUATION

With a group of experts from a wide cross-section of the Aluminium Foundry Industry (industrialists, academics, government organisations and suppliers), the first stage of the roadmapping process, "*Where are we now?*" and *Strengths & Weaknesses* (see Appendix, Tables 1 and 2) initiated.

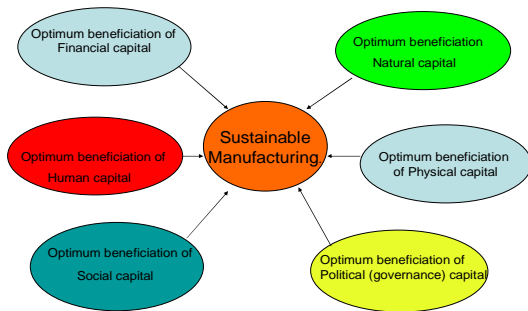
The clustered topics addressed issues regarding markets, skills, finance, technology and general industry items, in response to prompts such as:

- Who are our present customers (markets/drivers)?
- What are the trends and drivers?
- What are our current skills?
- What is our competitive position?
- Where does finance come from?

### 6. SUSTAINABLE DEVELOPMENT FRAMEWORK FOR METALS MANUFACTURING

#### 6.1 Introduction

The idea of 'capital' is a useful concept when discussing sustainable development and it represents the various important 'resources' which can, when benefited effectively, help us make huge strides in our quest for sustainable manufacturing.



**Fig. 1: Different types of Resources ('Capital')**

**6.2. *Optimum beneficiation of financial capital***

- Deliver long-term economic benefits
- Maintain accountability
- Taxes paid
- Maximum value addition to products
- Total revenue (GDP)
- Aluminium use per capita
- Total production (capacity %)
- Efficient resource use and lean manufacturing (internal scrap and waste/reject rates)
- Sustainability-related investment funding
- Encourage stakeholder involvement and shareholder goodwill and governance.

**6.3 *Optimum beneficiation of natural capital***

- Energy consumption - melting (gas/electricity/oil), efficient bulk melting and dosing furnaces
- Renewable energy
- Fresh water consumption
- Effluent management
- Climate gas emissions management
- SPL deposited
- Alloying consistency
- Life-cycle assessments
- Recycling and re-use patterns
- Clean production - responsible use of waxes, lubricants, fluxes, salts, oils, anodising and powder coatings)

- Greening programmes (maintain or enhance ecological integrity and biodiversity).

**6.4 *Optimum beneficiation of human capital***

- Sufficient R&D spend to develop people
- Skills development (internships/apprenticeships)
- Lean manufacturing (CSIR Lean Manufacturing Offering)
- Training performance
- Education and training for new entrants to industry
- Labour rights (wage levels)
- Workplace health and safety (incident rates, exposure and health assessments)
- Respect and protect workers

**6.5 *Optimum beneficiation of social capital***

- Community expenditure
- Community dialogues
- Community health initiatives
- Community involvement with greening and social beneficiation programmes
- Build community experience and well-being
- Meet the needs of current and future generations.

**6.6 *Optimum beneficiation of physical (material) capital***

- Regular maintenance of buildings and premises to adhere to local by-laws and regulations
- Regular investment in new capital equipment to ensure global competitiveness
- Ensure a good infrastructure
- Ensure an efficient supply chain and logistics
- Die change lead times
- Optimisation of tooling lead times
- Efficient transport equipment and utilisation and maintenance.

**6.7 *Optimum beneficiation of intrinsic capital (governance)***

- Corporate governance
  - Plant certification

- Value creation
- Transparency
- *Auditing of financial, environmental, social and quality management systems!*
- Customer relations, consumerism and consumption patterns
- Market intelligence regarding new markets/import replacements, etc.
- Utilisation of government assistance schemes.

- Establish a collaborative, interdisciplinary R&D and training regime for sustainability amongst academia/science councils/training institutions and industry representative bodies, i.e. develop a partnership between MAP, the Institute for Sustainable Studies (University of Johannesburg) and industry, in engaging in relevant R&D initiatives to assist the declining aluminium industry to realise its dormant potential in supplying volume markets.

## 7. IMPLEMENTATION PLAN

In the next phase of the project, the following research methodology is envisaged:

The first step will be a comprehensive literature study reviewing the work that has been done on environmental sustainability and the environmental awareness of decision-makers in the metals manufacturing industry, locally and internationally, and to investigate intervention models.

The study will also be aimed at improving insight into existing institutes and/or research paradigms addressing environmentally sustainable business practice.

## 8. OUTCOMES OF THE PAPER

The outcomes of this study will be to:

- Use the SD Indicators identified and explained in this paper for developing/enhancing the environmental sustainability awareness and knowledge of decision-makers in the aluminium die casting industry.
- Develop a set of interventions, guided by a 'Sustainability Index', to address the shortcomings and maintain and/or improve the strengths of a sustainability value system in the sector.
- Develop a sustainable ethos within the industry to enable industry to respond pro-actively to conformance to imminent environmental legislation.
- Develop a sustainable R&D paradigm for the aluminium casting industry.
- Develop an enabling context for the sustainable beneficiation of all resources.
- Establish a national qualifications framework for sustainable business practice (skills development).

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## 9. ENVISAGED CONTRIBUTION OF THE PAPER TO SCHOLARSHIP AND POLICY OR PRACTICE

It is envisaged that the study will contribute to:

- The development of a sustainable ethos within the metals manufacturing industry to enable industry to respond pro-actively to conformance to imminent environmental legislation.
- The development of a sustainable R&D paradigm for the aluminium casting industry.
- The development of an enabling context for the sustainable beneficiation of all resources.
- The establishment of a national qualifications framework for sustainable business practice (skills development).
- The establishment of a collaborative, interdisciplinary R&D and training regime for sustainability amongst academia, science councils, training institutions and industry representative bodies.

## 10. CONCLUSION

This paper presents an overview of sustainable development and some thoughts as to how the light metals industry could incorporate this philosophy into this sector's activities. These discussions should identify how effectively these principles could be applied to increase the contribution to South Africa's manufacturing/resource beneficiation transition to sustainable development.

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APPENDIX

**Table 1: Current situation in the aluminium industry**

<p><b>Markets/Drivers</b></p>	<ul style="list-style-type: none"> <li>• Lack of market intelligence (especially export markets)</li> <li>• Lack of a competitiveness benchmark</li> <li>• Global pressures (developing industries) require high volume at low cost - China/India</li> <li>• Automotive (excellent potential)</li> <li>• Aerospace (good potential - R&amp;D)</li> <li>• Transport (good potential)</li> <li>• Grid electrification (potential into Africa)</li> <li>• Mining - platinum/coal (limited potential)</li> <li>• Household appliances (low potential)</li> <li>• Chemical (promising potential)</li> <li>• General engineering (stable)</li> <li>• Raw materials abundance</li> <li>• South African global trade communication favourable</li> <li>• Environmental compliance (currently limited challenges)</li> </ul>
<p><b>Products</b></p>	<p><i>Automotive</i></p> <ul style="list-style-type: none"> <li>• Cylinder heads</li> <li>• Pistons</li> <li>• Engine covers</li> <li>• Mounting brackets</li> <li>• Alloy wheels</li> <li>• Housings (gearbox/starter motor/alternator/wiper motor/compressors/steering mechanism rack)</li> <li>• Steering wheel frames</li> <li>• Oil sumps</li> <li>• Inlet manifolds</li> </ul> <p><i>Aerospace</i> Electronic housings</p> <p><i>Transport</i></p> <ul style="list-style-type: none"> <li>• Engine parts (see automotive)</li> <li>• Winches, engine parts</li> <li>• Marine superstructure fittings (windows, brackets, antennae, etc.)</li> <li>• Rail bogie castings</li> </ul> <p><i>Electrification</i></p> <ul style="list-style-type: none"> <li>• Clamps</li> <li>• Connectors</li> <li>• Motor housings</li> <li>• Lamp fittings</li> <li>• Lighting accessories</li> <li>• Spacers - SSM future</li> </ul> <p><i>Household</i></p> <ul style="list-style-type: none"> <li>• Outdoor furniture, baths, lawnmowers, cookware</li> </ul> <p><i>Chemical</i></p> <ul style="list-style-type: none"> <li>• Petro-piping clamps</li> <li>• Connectors</li> <li>• Pipe elbows</li> </ul> <p><i>General engineering</i></p>

	<ul style="list-style-type: none"> <li>• Motor and pump housings</li> <li>• Electronic (housings/boxes)</li> </ul>
<b>Technology</b>	<p><i>Material alloys</i></p> <ul style="list-style-type: none"> <li>• All relevant casting alloys are available, e.g. 356, 357, 380, LM 11 (refer to <i>Introduction to Aluminium</i>, AFSA 1993 pp87-112)</li> </ul> <p><i>Process technology</i></p> <ul style="list-style-type: none"> <li>• Existing conventional casting processes</li> <li>• Sand/gravity/pressure/investment (ratios)</li> <li>• Poor process control scrap/wastes, maintenance, capex</li> <li>• Lacking in automation, quality control, product testing</li> <li>• Insufficient shot control amongst high-pressure die casters.</li> <li>• Efficiencies of scrap re-use are not well understood</li> <li>• Not much value addition to castings</li> <li>• TQM is lacking (refer to <i>SA Casting Industry Survey</i>, SAIF 2003)</li> <li>• Lead times for products as well as toolmaking are too long</li> </ul> <p><i>Environmental technologies</i></p> <ul style="list-style-type: none"> <li>• Energy efficiencies low</li> <li>• Lack of effluent control</li> <li>• Gas scrubbers mostly inadequate</li> <li>• Safety procedures lacking</li> <li>• Working conditions in factory (cleanliness, etc.) inadequate (Refer to <i>SA Casting Industry Survey</i>, SAIF 2003)</li> </ul>
<b>Skills</b>	<ul style="list-style-type: none"> <li>• Casting technology training in South Africa /practical</li> <li>• Insufficient skilled people in the foundry industry</li> <li>• Lack of investment in skills development for personnel</li> <li>• Difficult to attract people, especially youngsters, to this industry – parts manufacture is seen as providing limited intellectual challenge</li> <li>• Legislation prevents importation of skilled people</li> <li>• Lack of technology awareness</li> <li>• Lack of mentoring system</li> <li>• AIDS causes skills depletion and an unwillingness to train people</li> <li>• Difficult to get middle management</li> <li>• Management replacement is very difficult</li> </ul>
<b>Enablers</b>	<ul style="list-style-type: none"> <li>• A major advantage for South Africa is the relatively low cost of energy</li> <li>• Government incentives are positive</li> <li>• Commercial banks are co-operative</li> <li>• Opportunities are in niche markets for most foundries</li> </ul>
<b>Disablers</b>	<ul style="list-style-type: none"> <li>• Reluctance to re-invest in capital</li> <li>• Suppliers have monopolies</li> <li>• There are too many small companies – consolidation is needed</li> <li>• Lack of social investment culture</li> </ul>

The most encouraging point to emerge from this stage was that government regards the foundry industry as being of key importance to the South African economy and will therefore back it accordingly. In addition, the automotive sector has become particularly important in recent years and a strong and competitive foundry industry is needed to support this.



**Table 2: Current key strengths and weaknesses in the foundry industry**

<p><b>Strengths/ Opportunities</b></p>	<ul style="list-style-type: none"> <li>• The automotive, transport and aerospace sectors show growth potential for aluminium castings</li> <li>• Government regards the aluminium industry highly</li> <li>• R&amp;D from science councils</li> <li>• Skills Development Act</li> <li>• Incentives from government are designed to grow manufacturing and empowerment</li> <li>• Energy costs are still relatively low in South Africa</li> <li>• Scope for high-margin products ( assemblies)</li> <li>• Raw material in abundance</li> <li>• Traditional engineering versatility in the casting industry</li> </ul>
<p><b>Weaknesses/ Threats</b></p>	<ul style="list-style-type: none"> <li>• Market knowledge and international benchmarking is poor</li> <li>• There are insufficient skilled people - in-service skilling is lacking</li> <li>• Environmental issues are projected to be costly in the future (especially exports)</li> <li>• Margins are too low to allow re-investment in capital</li> <li>• Low efficiencies (scrap/defects too high)</li> <li>• Raw material (primary and scrap) pricing not conducive to growth of industry</li> <li>• Strong exchange rate impacts on export margins</li> <li>• Far from international markets (transport/lead times)</li> <li>• Historically negative attitude</li> <li>• 'Dumping' from Asia</li> </ul>