COPYRIGHT AND CITATION CONSIDERATIONS FOR THIS THESIS/ DISSERTATION

o Attribution — You must give appropriate credit, provide a link to the license, and indicate if changes were made. You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use.

o NonCommercial — You may not use the material for commercial purposes.

o ShareAlike — If you remix, transform, or build upon the material, you must distribute your contributions under the same license as the original.

How to cite this thesis

Lack of Training Opportunities in South African Foundries

A Minor Dissertation Submitted in Partial Fulfilment of the Degree of

MAGISTER PHILOSOPHIAE

in

ENGINEERING MANAGEMENT

at the

FACULTY OF ENGINEERING AND THE BUILT ENVIRONMENT

of the

UNIVERSITY of JOHANNESBURG

by

Jonathan Mkansi

November 2017

Supervisor: Dr. Hannelie Nel

Co-supervisor: Dr. Annlize Marnewick
DEDICATION

This research work is dedicated to my late mother Mainah Mkansi, my grandmother Sainah Mkansi and my three sisters Gift Mkansi, Vio Mkansi and Ursula Mkansi for your everlasting support and inspiration throughout my career.
ACKNOWLEDGEMENTS

Firstly, I would like to thank God for the gift of life He gave me and for His continuous guidance and protection throughout this project.

Secondly, I am very grateful to my supervisor Dr. Hannelie Nel and co-supervisor Dr. Annlize Marnewick for their valuable insights and support in making this research a success.

Thirdly, I hereby acknowledge the South African Institute of Foundrymen, all foundries which participated in the research interviews and the University of Johannesburg research team for their invaluable contribution to the completion of this study.
ABSTRACT

Lack of in-service training in the field of engineering metallurgy at local foundries has had a negative impact on the number of graduates who are offered an opportunity to complete practical training and consequently graduate. This also leads to a shortage of skilled foundrymen and foundry-women who are capable of taking the industry forward and helping South Africa compete with big producers of cast products such as China and India. Universities and foundries need partnership to establish ways in which foundry skills are taught to young technicians while they are nurtured for a brighter future.

To achieve this, a quantitative study was conducted and data were collected and analysed to investigate the participants’ understanding of lack of in-service training and its effect on the number of metallurgical students graduating each year. Expert review of the data collected was conducted, to complete triangulation of information. The data were aimed to answer all questions from 52 foundries using the minimum sample size formula. The statistical analysis was based on actual data collected from all foundries which were randomly selected. Using this information, three types of questions (yes/no questions, five-point Likert scale, most to least contributing factors) were adopted during interviews and document review.

Frequency and percentage distribution graphs were employed to display the results for easy interpretation of trends. Based on the data collected and analysed, three main factors (financial support and budget, lack of government support, and lack of training awareness) were found to contribute 71% of the problem and recommendations were made, based on these findings. It is also noteworthy that foundries were willing to assist wherever they could, if there was value that could be extracted from the training process.
# TABLE OF CONTENTS

1. Background .............................................................................................................................. 1
   1.1 Problem statement ................................................................................................................ 3
   1.2 The research questions .......................................................................................................... 3
   1.3 The purpose of the study ....................................................................................................... 3
   1.4 The objective of the study ..................................................................................................... 4
   1.5 Research design .................................................................................................................... 4
   1.6 Document layout .................................................................................................................. 5
   1.7 Chapter conclusion ................................................................................................................ 5

Chapter 2 ................................................................................................................................... 6

2. Introduction .............................................................................................................................. 6
   2.1 Structure of academic programme ...................................................................................... 6
   2.2 What is in-service training? ................................................................................................ 7
   2.3 How does in-service training work in South Africa? .......................................................... 7
   2.4 Lack of in-service training .................................................................................................. 7
   2.5 Importance and benefits of in-service training .................................................................... 9
   2.6 Foundry industry and training ............................................................................................ 10
       2.6.1 Global foundry trends .................................................................................................. 11
       2.6.1.1 China ...................................................................................................................... 12
       2.6.1.1.1 Foundry industry in China .................................................................................. 13
       2.6.1.1.2 Challenges facing China ...................................................................................... 14
       2.6.1.3 Current projects ....................................................................................................... 15
       2.6.1.4 Other skills development policies .......................................................................... 16
       2.6.1.2 India ....................................................................................................................... 17
       2.6.1.2.1 India and the foundry industry ........................................................................... 17
       2.6.1.2.2 Vocational Training in India .............................................................................. 18
       2.6.1.2.3 Other skills development policies ........................................................................ 19
       2.6.1.3 Brazil and training ................................................................................................... 19
       2.6.1.3 Russia and training .................................................................................................. 21
   2.7 Local Foundries and training ............................................................................................. 21
       2.7.1 The importance of South African foundries in developing students ......................... 24
       2.7.2 Challenges in the South African foundries .................................................................. 24
5.1 Recommendations ................................................................................................................. 66
  5.1.1 Financial Support and Budget .......................................................................................... 66
  5.1.2 Government Support ....................................................................................................... 66
  5.1.3 Lack of training awareness .............................................................................................. 66
  5.1.4 Documents Review/Training Programme ....................................................................... 67
5.2 Summary of the dissertation .................................................................................................. 67
# LIST OF TABLES

Table 1. 2012 Global Production in metric tons (World Foundry Organization, 2013).  
.................................................................................................................................................................................. 12

Table 2. Geographical location of foundries in South Africa (SAIF, 2015)............ 22

Table 3. Industry structure by foundry type in South Africa (SAIF, 2015)............. 22

Table 4. Estimated annual foundry production by metal type in South Africa (SAIF,  
2015). ........................................................................................................................................................................ 23

Table 5. Problems and questions used to design interviews questions. ............... 32

Table 6. Factors grouped from answers by respondents ................................. 52
LIST OF FIGURES

Figure 1. The development trend of the Chinese foundry Industry (Chinese Foundry Industry, 2015). ................................................................. 14
Figure 2. Indian foundry production of castings in million tons from 2005-2014 (Indian Foundry Industry, 2015). ......................................................... 18
Figure 3. Brazil foundry production output from 2006-2014 (Brazil Foundry Industry, 2015). .............................................................................. 20
Figure 4. Skills base in the South African foundries (NFTN, 2015). ............... 23
Figure 5. Major challenges in the foundry industry in South Africa (NFTN, 2015). ... 25
Figure 6. Designation of each respondent in their organisations...................... 39
Figure 7. Departments in which respondents work in their foundries. ............... 40
Figure 8. Importance of in-service training as understood by respondents. .....  41
Figure 9. Training opportunities given to students in the past. ....................... 42
Figure 10. Training opportunities given to students in the past. ....................... 43
Figure 11. Skills development and training to compete globally ..................... 44
Figure 12. Foundries that would recruit students each year if they never had to finance the training. ................................................................. 45
Figure 13. Respondents' satisfaction with study policies................................. 46
Figure 14. How foundries view government involvement in promoting in-service training. ........................................................................... 47
Figure 15. Management is always looking at ways of helping students with training. ...................................................................................... 48
Figure 16. These foundries trained employees in the last six months............... 49
Figure 17. Respondents who believe local foundries could compete globally if training and skills development was given priority and resources made available. 50
Figure 18. Possible factors ranked against one another from main to least contributing.................................................................................. 51
Figure 19. "Budget" was rated from 1 to 10 by all respondents......................... 53
Figure 20. "Lack of training awareness" was rated from 1 to 10 by all Respondents ................................................................. 54
Figure 21. "Lack of government support" was rated from 1 to 10 by all Respondents ...................................................................................... 55
Figure 22. Foundries with training documents in place. ................................ 59
Figure 23. Training opportunities given to students in the past. ......................... 60
Figure 24. Foundries with in-service training documents of eight foundries .......... 61
Figure 25. Foundries that are willing to introduce or update training documents ..... 62
### LIST OF ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BRICS</td>
<td>Brazil, Russia, India, China and South Africa</td>
</tr>
<tr>
<td>GDED</td>
<td>Gauteng Department of Economic Development</td>
</tr>
<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
</tr>
<tr>
<td>GFTC</td>
<td>Gauteng Foundry Training Centre</td>
</tr>
<tr>
<td>In-service Training</td>
<td>Work Integrated Learning/Training</td>
</tr>
<tr>
<td>NFTN</td>
<td>National Foundry Technology Network</td>
</tr>
<tr>
<td>SAACE</td>
<td>South African Association of Consulting Engineers</td>
</tr>
<tr>
<td>SAIF</td>
<td>South African Institute of Foundrymen</td>
</tr>
<tr>
<td>SAQA</td>
<td>South African Qualification Authority</td>
</tr>
</tbody>
</table>
Chapter 1
Introduction

1. Background
Foundries generally melt ferrous and non-ferrous metal charges and/or alloys and reshape them into products through the pouring and solidification of the molten metal or alloy into moulds (Juganan and Paterson 2012). The foundry industry in general is a complex and very diverse sector. It consists of a wide range of processes from very simple to complicated practices. Differences that exist within this industry are based on the type of metal melted, with the main distinction being made between ferrous and non-ferrous foundries. Philip (2012) says that since castings in general are semi-finished products, most foundries are situated not far away from customers, where the products are often machined, assembled and shipped to end users.

Ribeiro (2009) reports that the South African manufacturing industry had been falling into decline with job losses for the past ten years. Local foundries are not an exception and have experienced bigger challenges of late, and history indicates that they have been falling into decline for more than a decade now. “Market research conducted by the South African Institute of Foundrymen (SAIF) in 2015 indicated that about 170 foundries melt metals and alloys for a wide variety of applications and about 20 produce the bulk of the output, mostly for the mining sector” (Jardine, 2015). South Africa consisted of about 450 foundries in the 1980s and around 200 in 2003. Between 2007 and 2011 another 13% closed and employment in the industry declined by 30%.

Jardine (2015) further mentions that the current crisis in the mining, agriculture and engineering sectors added to a big drop in demand for digging-machine blades, ore-truck compartments capable of carrying loads of hundreds of tons, grinding media, metal balls that crush rocks, and many other components which have been produced and mastered by most South African foundries. Industrial strikes and political decisions also resulted in imports replacing the production of goods such as manhole covers, pumps, valves and mostly railway components for the manufacture of trains (Jardine, 2015). The castings come from China, India and Brazil and it is
estimated that around 80% of manufactured products have been assembled using castings. The foundry sector is one of the backbones for all manufacturing and tools and dies making. Ribeiro (2009) further states that metal and manufacturing industry plays a major role in the employment of young South Africans. The tool making sector includes artisans and machines operators making jigs, dies, moulds, cutting tools, gauges and many other products which are used in manufacturing small components to larger castings weighing more than 30 tons (Jardine, 2015).

John Davies, who is the former chief executive officer at the South African Institute of Foundrymen states that “one major challenge facing the foundry industry is the influence of government in assisting university students with in-service training to help improve the industry standard, while ensuring that knowledge and skills is transferred to the younger generation” (Davies, 2016). Davies (2016) continues to say that the National Foundry Technology Network (NFTN), in partnership with the SAIF, is currently conducting several trainings to reduce skill shortage in the local metal castings sector. These core training programmes include the Gauteng Foundry Training Centre (GFTC), in Kwa-Thema, on the East Rand, which was launched in September 2013. The NFTN ensures that apprentices receive training in different foundry skills, including melting, moulding and pattern making (Davies, 2016).

The involvement of the Department of Trade and Industry is a direct indication that most South African foundries have significantly reduced the number of students completing practical training in foundries for many different reasons. Maya (2014) also discovered similar challenges of skills shortage and development of young engineers at the only state-owned power utility in the country. These are university of technology students seeking one year of industrial training before graduation. Many young students are unaware of the importance of the foundry industry in their careers as metallurgy technologists. Like any other industry, it needs to attract students of the right quality and in correct numbers to meet its operating requirements (Maya, 2014).

Moodley (2008) comments on the shortage of engineering skills in the country and remarks that the industry is highly aware of the challenge. For these reasons, it is extremely important that current affairs of the industry are communicated to young students, and that they are mindful of different inspiring opportunities offered by the
industry for different kinds of talents (Bagshaw, 1996). It is these opportunities that need to be made available to students who have completed theoretical studies and are looking for one year of in-service training before graduation. It is the responsibility of the government, universities and organisations (employers) to ensure maximum support and availability of these scarce opportunities.

1.1 Problem statement
In-service training is mandatory for all diploma students as one step to completing the three-year programme and there has been a great decline in the number of students given in-service training in the foundry industry in recent years (Jardine, 2015). This research aims to establish the main reasons for the decline in training of undergraduate students in local foundries.

1.2 The research questions
A. What are the main reasons for South African foundries not taking students for in-service training?
B. How can stakeholders of this industry work together to promote in-service training?

1.3 The purpose of the study
The foundry industry has been notoriously known to be a very difficult and challenging industry (Philip, 2012). There have been fewer opportunities to conduct studies on the work and value added by students to respective foundries in the last decade or two. Subsequently, this has resulted in a gap in academic literature. More precisely, there is a lack of academic literature on the careers of students conducting in-service training and the factors that lead to retention thereafter (Schraeder, 2009).

Firstly, the research study aims to contribute to the knowledge base in respect of young and upcoming students willing to pursue a career in engineering metallurgy, and the retention factors by foundries.

Secondly, the research study plans to contribute to the knowledge base of South African foundries and highlight how students can work harder to move the industry
forward (Maya, 2014). Foundries need to know what students expect from them, and similarly, students need to know what foundries expect from them.

Lastly, the research study aspires to contribute to the knowledge base of South African universities offering metallurgy technologist qualifications. This will ensure that universities in partnership with the Department of Education prepare curricula that are useful and suitable for the South African foundry industry. South Africa is famous for producing great-minded metallurgists in the foundry industry (Davies, 2016). Despite this great success in the past, the future of foundrymen and -women with a metallurgical background is challenged year after year. This research aims to explore the reasons why most foundries do not take students for in-service training.

1.4 The objective of the study
The objectives of this study are as follows:

A. To understand why South African foundries do not take students for practical training before graduation.
B. To recommend ways in which government, universities, and foundries can work together to promote in-service training.

It is important for universities to equip students with relevant knowledge that will be useful and beneficial to the foundry industry. There are great potential benefits from the research findings, as actions will hopefully be taken based on the outcome and recommendations. It is very important to carry out this research to help students and foundries work together to boost skills development in South Africa.

1.5 Research design
A quantitative research method was considered appropriate as it is a commonly used method for answering questions using mathematical methods. Based on the number of foundries in South Africa and the potential of employing students, 52 different foundries within the research setting were selected for the research study. One in-depth interview was conducted face-to-face with the industry expert while document review was employed to completed triangulation of data. The data collected were mostly nominal data and very few were interval data. Frequency distributions and percentage distributions were employed to display the results.
1.6 Document layout

Chapter 2 consists of the academic literature reviewed to understand what other researchers have written on in-service training or training in general in the South African foundry industry and the rest of the world. There is limited literature published on this subject in the foundry industry, however lack of training remains a common issue in many other industries, and their (those industries’) solutions could be adopted in foundries.

The literature discusses what other industries have implemented to reduce skills and training is explored in detail. Data collection, ethical considerations, reliability and validity and other topics are covered in Chapter 3. Chapter 4 outlines the results from interviews, document review and expert comments. Based on the findings, a detailed discussion in the same chapter is covered with reference made to literature review. Conclusions and recommendations were drawn based on the results and analysis as covered in Chapter 5.

1.7 Chapter conclusion

The aim of this research work is to evaluate and understand the lack of in-service training for university students and the effect on the number of metallurgical graduates. The success of this study will benefit students and the foundry industry to improve skills and move the industry forward.
Chapter 2
Literature Review

2. Introduction
The foundry technology II student’s handbook (2008) defines foundry and metal castings as “the process of melting metals of different specifications and alloys and pouring in cavities or moulds to give desired shape of the final component as per required application”. Ribeiro (2009) suggests that a great amount of research work has been conducted in the melting and casting of metal in the past decades in South Africa and around the world. Monroe (2008) adds that the drive for successful castings without defects and ones that are produced timeously, at very competitive prices, has been an ongoing process since metals were poured and cast into useful shapes. During the process of change and improvement, the global foundry environment faced different challenges including but not limited to work-integrated learning and skills development (Maupa, 2014).

2.1 Structure of academic programme
A three-year diploma programme was introduced to South African Technikons many years back (Du Plessis et al., 2014). Technikons (currently known as universities of technology) designed curricula for engineering students to complete mandatory one-year training at any company in line with what the students are studying. This training is completed in one full year after successfully completing two years of course work (Abrahams, 2014).

Students are often compensated by the company where the training is conducted. Only after successful completion of the two-year theory and one-year in-service training are students able to graduate with a national diploma. There is, however, constant improvement of syllabi to ensure that universities prepare students for the challenging work life ahead. This is evident from the introduction of a new programme at the University of Johannesburg in 2017, where a three-year bachelor of engineering technology (BEngTech) was approved by the Department of Higher Education and Council.
2.2 What is in-service training?
Smith (1980) postulates that the need to reduce the gap between course work at universities and workplaces had led to the development of practical training for colleges and universities. In the views of Janneker (2006), practical work experience or in-service training is an essential milestone during studies, provided that the course work is successfully completed. According to a similar study conducted by Van Schoor and Erwee (2000), the marketing department of the University of Free State found that implementation of work-integrated learning approach in the undergraduate programme would be one of the most effective approaches in helping students adapt to the work environment.

2.3 How does in-service training work in South Africa?
To prepare students for industry challenges and requirements, practical training or in-service training was introduced. This training programme is focused on developing and grooming deserving students for future technical demands and responsibilities (Johan, 2015). A student will apply for training opportunities at different companies as required by the university. The purpose of the practical 1 and 2 (P1 & P2) training programme is to allow individuals to get the necessary practical exposure to enable them to complete their qualification. The training programme is conducted in line with university requirements which include exposure to allow students to learn as much as possible, as well as completion of a training report every six months for the duration of the programme (Mukeredzi and Mandrona, 2013).

2.4 Lack of in-service training
A study conducted by Smith (1980) indicates that lack of in-service training and education in foundries is a global challenge, as the United Kingdom is also faced with the same dilemma. The idea of closing the gap between school and industry was developed to empower young talent before they start with full-time working careers. This technique has been successfully used for many years, but in recent times a significant drop in the number of students partaking in training has been recorded (Jardine, 2015). Mtombeni (2006) maintains that the most difficult positions for companies to fill are those in the engineering field and skill trade. This could be attributed to various factors such as an economic crisis or the impact of imported
products. This is against predictions that most companies would be, by now, able to employ talented and well-equipped graduates as the employment rate decreases every day (Janneker, 2006). “With unemployment in South Africa continuing to be high, it is disturbing to know that companies continue to have difficulty filling positions. South Africa’s continued skills shortage is being compounded by a lack of technical skills, which has a negative impact on employment across many sectors.” (Steyn, 2015:4).

Percentages reported by employers on the difficulties of filling engineering and trade skills positions has increased considerably in the last few years (Smith, 1980). Romo (2014) looked at challenges faced by different countries as far as training and availability of engineers. Eight percent of the companies in those eight countries indicated difficulty in finding the best candidates to fill vacancies. In 2015, a similar survey was conducted again and a spike in the number of companies facing challenges of filling positions was recorded, at 31%. Local employers have indicated that lack of training and job opportunities are due to environmental or market factors, lack of applicants for the positions and lack of technical skills obtained (Yorke, 2006).

Looking at the impact of skills shortages across industries in South Africa, companies are challenged to look at other options to reduce the effect of lack of training and lack of skilled employees in their day-to-day operations (Booysen, 2000). A solution given by most companies to face this challenge is to adopt people practices and to explore new talent sources.

Managing director of manpower group South Africa Lyndy van den Barselaar says: “To effectively tackle the skills deficit, it is imperative that provincial government, together with the public and private sectors, continue to support skills training and development,” (Steyn, 2015:1). Lyndy van den Barselaar continues to say that “this is not only important for those wanting to enter the job market, but also for existing employees, as technology in the workplace is rapidly evolving and requires all employees to constantly up-skill,” (Steyn, 2015:1).
2.5 Importance and benefits of in-service training

Taymaz (1997) mentions that in-service training is the process that provides students with an opportunity to do practical work for one year to complete the study programme. In-service training imparts knowledge and the necessary skills to perform job descriptions and activities set by universities and companies. These skills are necessary to help students in their future endeavours. McClelland (2002) agrees with Taymaz (1997) and defines training as an activity that changes people's behaviour and the way they conduct and perform their jobs. In-service training and the training of employees in general is an essential part of human capital, as many companies now invest resources in making sure that skills are developed and most importantly, in the retention thereof (Smith, 1980).

Training of staff and that of new recruits is an important activity performed by the human resource management and talent development department (Odini, 1999). Apart from helping students complete their mandatory one year of training in the industry, Malone et al. (2000) suggest that training is the vital tool for motivating employees and increasing productivity in the workplace.

An increase in the demand for companies to be more competitive to both local and international markets has encouraged developments in the training of employees and new graduates (West et al., 2010). It is often a great idea to train an employee that has been with the company for a little longer as a sign of commitment to staff development, than getting someone who is well trained in the job from other companies (Miller and Friemen, 1980). Employees often recognise their employers' training and development plan efforts; this could also be a way of retaining some of the hardworking employees for years to come (Yong, 2003).

Kouh (2013) points out that training is often demanding and quite costly, and needs a well-structured programme to realise all benefits. However, seeing employees get empowered to work independently and able to exercise a higher mental capability is far more rewarding for government and employers (Wagner and Roland, 1992). One would perhaps argue that the increase in skills development that has been seen recently is related to the belief that many organizations have come to realize that their existence is directly dependant on attracting, developing and retaining the best young graduates and employees (Sithole, 2009). When young engineers are given
training and human and financial resource support, the possibility of greater inventions and new ideas coming forth is higher, which is a benefit for companies (Gerryts, 2013). The increase of projects demands a high number of qualified and hardworking engineers to help successfully complete projects to sustain and grow the economy going forward, thus the urgency of training students and employees cannot be ignored (Nenzhelele, 2014).

Nenzhelele (2014) continues to indicate that South Africa needs to develop training strategies which will be effective in closing the gap in skills development. Thirty-seven thousand employees from twenty-seven countries were surveyed and data were collected to determine the skills shortage. The results indicated that worldwide, engineering careers were the fourth hardest for companies to fill, whereas in South Africa, it was the greatest challenge for companies to fill in vacancies.

A further survey conducted by the American Foundry Society in the late 1990s and early 2000s revealed that a lack of educated employees was the highest challenge faced (Maher and Graves, 2008). Jennifer who is the Director of Education at the Cast Metal Institute emphasised capital investment in education says: “Training and development should never be considered an expense but rather, it should be viewed as an investment” (Jardine, 2015). On the other hand, Mike Selz, current President of the Society, states: “The goal of education is to educate the new talent pool and bring the current workforce up to speed” (Jardine, 2015).

2.6 Foundry industry and training
Foundry operations are more demanding than one could ever imagine but this industry often gives rewards, and challenges are part of the day-to-day operations (Jardine, 2015). Some of these challenges are beyond the control of foundry managers and foundry owners. Jardine (2015) continues to say that the first challenge is the fact that foundries have become more global in their trading practice and because of this, exchange rates have become one of many deciding factors.

Foundry castings and all other steel products have lately been priced with consideration to the global market and competition (Ribeiro 2009). Some countries like China and India have worked on reducing their prices to make exports more attractive. Weak currencies are more favourable for exports, whereas strong
currencies tend to favour imports. Secondly, environmental regulations are being reviewed and tightened with hefty fines in cases where foundries fail to comply. This challenge is also out of direct control of foundry owners and managers. Fitzsimons (2012) continues to say that laws and regulations on emissions of gases and other toxic fumes are set by government organizations.

Foundries are audited and regularly checked for compliance. There is a number of key factors however, that are under the control of foundry workers and management. Evidence shows that critical factors are: safety, education, recruitment and retention, marketing, research and service (Fitzsimons, 2012). These factors have a direct or indirect influence on the financial performance of foundries. The use of chemical, metallurgical, and mechanical analysis, together with continuous improvement in quality has enabled foundries to produce complicated castings which have revolutionised the human journey. Cast iron has been perfected in casting valves for the supply of safe drinking water to billions of people around the globe. All methods of transport depend on castings for daily operations.

2.6.1 Global foundry trends

Foundries globally have seen a slight increase in production in recent years, but only a few countries have benefited from the increase in castings demand (Smith 1980). In 2014, the global foundry castings production was higher than 103.6 million metric tons, which is an increase of 2.3% compared to 2013 (Juganan and Paterson 2012). Juganan and Paterson (2012) continue to state that the total foundry casting production in 2014 was at an increase of only 2.38 million metric tons when compared to the previous year of 2013.

This rate of growth in 2014 is a concerning decline from 2013’s 3.4% positive market boost. The census conducted in 2014 included thirty-seven countries from four different continents. The countries where the census was conducted indicated that 14 countries recorded a decline in shipped tonnage, while Twenty-three indicated a growth in shipped metal. Table 1 below shows global foundry casting tonnages recorded in 2012. Challenges facing South Africa have become more difficult to overcome, as the country is not amongst the top ten countries producing million metric tons annually.
Table 1. 2012 Global Production in metric tons (World Foundry Organization, 2013).

<table>
<thead>
<tr>
<th></th>
<th>Country</th>
<th>Number of Foundries</th>
<th>Tonnages per annum</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>China</td>
<td>30,000</td>
<td>42.5 million</td>
</tr>
<tr>
<td>2</td>
<td>U. S. A</td>
<td>2,010</td>
<td>11.78 million</td>
</tr>
<tr>
<td>3</td>
<td>India</td>
<td>4,500</td>
<td>10.57 million</td>
</tr>
<tr>
<td>4</td>
<td>Japan</td>
<td>2,113</td>
<td>5.34 million</td>
</tr>
<tr>
<td>5</td>
<td>Germany</td>
<td>605</td>
<td>5.21 million</td>
</tr>
<tr>
<td>6</td>
<td>Russia</td>
<td>1,240</td>
<td>4.3 million</td>
</tr>
<tr>
<td>7</td>
<td>Brazil</td>
<td>1,277</td>
<td>2.86 million</td>
</tr>
<tr>
<td>8</td>
<td>Korea</td>
<td>897</td>
<td>2.44 million</td>
</tr>
<tr>
<td>9</td>
<td>Italy</td>
<td>1,111</td>
<td>1.96 million</td>
</tr>
<tr>
<td>10</td>
<td>Ukraine</td>
<td>805</td>
<td>1.53 million</td>
</tr>
</tbody>
</table>

2.6.1.1 China

China, a global powerhouse and the biggest developing country in the world, faces critical skills shortage along with the difficulties of dealing with an ageing population and a shrinking labour force. Labour costs are getting higher each year and vocational training is unable to bridge the gap fast enough (Omar et al., 2009). The quality of trained citizens and the speed of training and placement of properly trained workers is the best key that needs to be perfected to ensure that China’s growth and development does not come to a standstill.

This section of study highlights gaps in supply and demand for skilled labour, mostly in the engineering and the manufacturing sector in China (Omar et al., 2009). Manufacturing continues to be one of the main supports of the Chinese economy, and will continue to be one of the main contributors to the Chinese economy for many years to come. In terms of an employment growth report, between 2003 and 2013, the industries experienced the fastest growth and demand for products
worldwide, as well as the domain for skilled workers like artisans, electricians, and furnace manufactures to mention just a few (Libo, 2015).

2.6.1.1.1 Foundry industry in China

China remains the biggest producer of foundry castings, with 46.5 million tons in 2014 and having 30,000 foundries (Libo, 2015). One might think that with a population of approximately 1.4 billion people and being a technology-driven country, China would be faced with other challenges but not that of skills development. However, with a population of that magnitude, it is not surprising that skills development continues to be a challenge in China. This is coupled by the migration of students to further their studies overseas, especially in the United States of America (Woon et al., 2007:30). In 2013 alone, it was reported that 450 000 students migrated to other countries for better training opportunities.

China uses vocational and technical education as a way of describing different modes of vocational and technical education and training (Omar et al., 2009). The large production tonnages in steel are attributed to hard work done by mostly unskilled labourers, under poor working conditions (Omar et al., 2008). Figure 1 shows the Chinese foundry production output on the rise, but with a downward trend. At the BRICS conference held in Russia, Libo (2015) revealed that China was faced with own challenges.
2.6.1.1.2 Challenges facing China

A. The skills of students and the market demand
The biggest problem facing the industry is that school and university programmes, courses and enrolments are controlled by the Department of Higher Education and this is normally done without a proper consideration of the industry needs (Libo, 2015).

B. Government subsidies for training
Vocational education in China is also experiencing a decline in the number of candidates and enrolled students. As far as higher vocational education is concerned, government spending still favours traditional education over vocational training. Institutions that offer vocational education training receive only about a third of the government funding per student allocated to universities (Omar et al., 2009). These institutions are further faced with other serious challenges such as the quality
of the practical training, lack of participation from some of companies, and a lack of effective support between schools and companies (Libo, 2015).

C. Migration of skilled workers
The younger generation of migrant workers is better educated than their parents, though skill levels are still relatively low and job training opportunities have never been sufficient. Workers coming from underdeveloped locations are employed mostly in the manufacturing and construction industries. These workers do not only have low income and little social security, they also have no access to formal skills training, thus reducing their chance to further their careers. Reports show that about 33% of migrant workers have received some formal training, and only 5.9% have vocational or technical certificates (Libo, 2015). This indicated the global challenge of education and training for skills development, which is needed to bring about a rise in the number of engineers and benefit market growth.

2.6.1.1.3 Current projects

A. Unemployment monitoring system
The government uses economic, administrative and legal measures, to ensure efforts are made in controlling unemployment and also to eliminate challenges such as rapid growth of the unemployed groups and concentrating of the unemployed masses in one area (Woon et al., 2007:30). The Chinese government has been making other efforts in controlling the laid-off activities, raising the awareness of social responsibility among company owners and directors, making more efforts in developing a collective bargaining structures going forward. To organise the benefits balance between companies and workers and enhance the stability of employment, the government, the trade unions and companies have initiated the labour relations regulatory mechanism which is known by autonomous consultation by both the trade union and the management and controlled by the government (Libo, 2015).

B. Employment Strategy going forward
Like any other developing country with a larger population, China is and will still be faced with pressures and challenges in the future (Woon et al., 2007:30). Solving the
employment challenges in China will bring some positive energy in the future such as the support by government on the issue of employment and re-employment, socio-economic development, sustainable and rapid economy growth and the promise by government that the system of proactive employment policies will always be further reviewed and improved regularly (Libo, 2015).

C. Challenge to employment

Some positive achievements through implementation of policies have already been evident. However, the government is fully aware that in a country with a large population, solving the employment problem will take a longer time than expected. The positive start to dealing with unemployment has brought some motivation and trust that the government is dealing with the problem as promised (Libo, 2015).

2.6.1.1.4 Other skills development policies

A. Schools and universities have been given greater autonomy, with more training facilities so that the educational institutions can better understand the needs of local companies and adjust the training style accordingly. The joint training between companies and universities was very important and effective in the process of sourcing and talent management.

B. Government grants were approved for vocational training to help underprivileged citizens gained much needed skills.

C. Better and much improved training models in which companies play a major role have been established.

D. Artisan training has been promoted.

E. At the top government level, plans to stop monopolies have been implemented to help allocate human capital more efficiently.
2.6.1.2 India
It is estimated that by the year 2025, at least 70 % of the population in India will be of working age. This demographic mix could give India an advantage over the developed and developing countries where a larger percentage of the population would by then be past retirement. This advantage could easily be seen to benefit India within the BRICS countries (Institute of Indian Foundry, 2015). However, this demographic set-up can easily turn into a demographic disaster if many of the working population remains unemployable because of lack of skills. In the past, it has been recorded that barriers to entry into vocational training set-ups was high. For instance, the structure required secondary education as a requirement for enrolling into vocational training programmes (Institute of Indian Foundry, 2015).

This stops many illiterate or less educated workers from even entering the formal training system. In contrast, the Chinese vocational education and training programme, which shares some similarities with India’s system, targets a larger population of its working age group and is higher. Comparing South African and Indian training systems to Chinese government, it is clear that the former has specific initiatives at the local government level to train unskilled and uneducated migrant labour for sectors like construction, while such programmes are not yet visible in India (Institute of Indian Foundry, 2015).

2.6.1.2.1 India and the foundry industry
India is the third largest producer of metal castings after China and USA, with nearly 4 600 plants and 10 million metric tons of production per annum (Institute of Indian Foundry, 2015). Indian foundries employ 2 million direct and indirect employees with 19 major foundry clusters (Institute of Indian Foundry, 2015). It is estimated that only less than two percent of these workers have higher education qualifications. Like China, there are few technical training opportunities in Indian foundries and higher production values are related to population and hours of labour (Gamboa and Namasivayam, 2014).

The annual report presented at the BRICS foundry conference in Russia in 2015 indicated an average production of 2 100 tons per year per foundry. The Institute of Indian Foundry (2015) also admitted that skills development remains the top
challenge facing the foundry, however the government is supporting the “Make in India” campaign to increase the ease of running businesses as well as infrastructure development, to encourage investments in manufacturing and new initiatives and bring about cooperation in skills development and education (Morgan and Turner, 2000). Figure 2 shows the Indian foundry production and the challenges reflected on the total output from 2005-2014.

![Indian Foundry Output](image)

**Figure 2.** Indian foundry production of castings in million tons from 2005-2014 (Indian Foundry Industry, 2015).

### 2.6.1.2.2 Vocational Training in India

Just like many developing countries, vocational training in India is offered outside the formal schooling system and accommodates people with minimum school education. This section will only cover vocational training initiatives supported by the Indian Ministry of Labour and Employment, which has an obligation to train at least 100 million people of the government’s target to skill 500 million people by year 2022. There is however, complaints that placement outcomes from these training facilities have also remained poor in the last few years (Gamboa and Namasivayam, 2014).

Some government reports have attributed this challenge to a mismatch between training delivered and that which is required, and lack of participation from private sector. During the budget speech for the financial year 2004-2005, the Minister of
Finance announced a programme to upgrade 500 schools into specialised centres of excellence to help increase number of people trained. Moreover, in 2007, the Ministry of Labour and Employment announced a plan to upgrade more than 1000 schools by involving private sectors for a five-year programme as a start. However, lack of direction due to internal battles between government leaders has delayed the implementation of these programmes (Gamboa and Namasivayam, 2014).

2.6.1.2.3 Other skills development policies
As a fast growing developing economy, India will always need skilled workers who will contribute to the country’s growth. Multiple skill development programmes have been initiated in the country but it appears that these projects are unable to create ways for workers to be trained as planned.

A. The government needs to create a conducive environment and provide incentives for small and medium scale companies to engage in training programmes. The government has rolled out controlled programmes to give tax rebates to small sized firms that invest in training their employees.

B. The central government has also initiated sponsorships for individuals who are willing to be trained and these are the people who stand a good chance for decent job positions.

c. The Indian government has also copied the Chinese model of construction labour bases where local governments have formalised the process of training and transfer from skilled workers to migrant construction or manufacturing workers.

2.6.1.2 Brazil and training
The report from Brazil Foundry Industry (2015) suggests that the country had never recovered from the 2008 world financial crisis as seen in Figure 3. A study by Junaini et al. (2008) earlier found that the same challenge had negatively affected training and education, resulting in poor skills development. There are very few trained metallurgists in the foundry industry, hence lower tonnage is produced. Asia contributes to 27% of all casting imports in Brazil. The country has planned to invest 880 million dollars to increase production to 400 000 tons per annum that is needed
to meet the growth needs in the automotive, mining, railway and wind generation sectors (Brazil Foundry Industry, 2015).

**Figure 3.** Brazil foundry production output from 2006-2014 (Brazil Foundry Industry, 2015).
2.6.1.3 Russia and training
Russia is the 6th largest producer of foundry castings with 4.2 million tons from 1 120 foundries and only 2% is exported (Dibrov, 2015). There is still a large amount of foundry casting imports from Asia to Russia. Only 4.8% of foundry employees are engineers, with 3% being managers and the rest being workers. The percentages indicate the need to encourage investment in education and skills development. Dibrov (2015) suggests that Russia has developed and trained more students and their tonnage output is based on smarter ways of producing like developed countries such as Germany (Harvey, 2004).

2.7 Local Foundries and training
South Africa has been a major player in the production of good grade foundry castings and supplying it to the rest of the world. The industry has however contracted significantly from 2007 (Davies, 2016). There was a 43% reduction in production output from 660 400 tons to 375 240 tons between 2007 and 2013. This decrease could be attributed to foundry closures of 36% since 2007, reducing to 170 foundries in 2015.

The South African Institute of Foundrymen states that the industry consists of big players of more than 1 000 employees, as well as small foundries with less than 10 people, who are mainly owners and close relatives (Davies, 2016). Ferrous and non-ferrous castings are produced locally, and at a high standard, with value-adding activities such as machining, assembling, etc. Tables 2, 3 and 4 as well as Figures 4 and 5 show the location of foundries, foundry types, foundry production and the skills base in South Africa.
Table 2. Geographical location of foundries in South Africa (SAIF, 2015).

<table>
<thead>
<tr>
<th>Province</th>
<th>No. of foundries 2003</th>
<th>No. of foundries 2007</th>
<th>No. of foundries 2015</th>
<th>% of total foundries 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gauteng</td>
<td>143</td>
<td>141</td>
<td>114</td>
<td>66%</td>
</tr>
<tr>
<td>Kwa-Zulu Natal</td>
<td>26</td>
<td>25</td>
<td>20</td>
<td>12%</td>
</tr>
<tr>
<td>Western Cape</td>
<td>33</td>
<td>32</td>
<td>14</td>
<td>8%</td>
</tr>
<tr>
<td>Eastern Cape</td>
<td>20</td>
<td>20</td>
<td>8</td>
<td>5%</td>
</tr>
<tr>
<td>Free-State</td>
<td>13</td>
<td>13</td>
<td>5</td>
<td>3%</td>
</tr>
<tr>
<td>North-West</td>
<td>13</td>
<td>13</td>
<td>4</td>
<td>3%</td>
</tr>
<tr>
<td>Northern Cape</td>
<td>7</td>
<td>6</td>
<td>3</td>
<td>2%</td>
</tr>
<tr>
<td>Mpumalanga</td>
<td>15</td>
<td>15</td>
<td>2</td>
<td>1%</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>270</strong></td>
<td><strong>265</strong></td>
<td><strong>170</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

Table 3. Industry structure by foundry type in South Africa (SAIF, 2015).

<table>
<thead>
<tr>
<th>Foundry Type</th>
<th>No. of foundries in 2003</th>
<th>No. of foundries in 2007</th>
<th>No. of foundries in 2014</th>
<th>2014 v/s 2007 change in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ferrous (Iron and Steel)</td>
<td>110</td>
<td>110</td>
<td>89</td>
<td>- 19%</td>
</tr>
<tr>
<td>Non-Ferrous (Aluminum, Brass &amp; Zinc) Sand, Gravity, Low Pressure</td>
<td>117</td>
<td>119</td>
<td>50</td>
<td>- 57%</td>
</tr>
<tr>
<td>High Pressure Die-casters</td>
<td>36</td>
<td>32</td>
<td>27</td>
<td>- 16%</td>
</tr>
<tr>
<td>Investment Casting</td>
<td>7</td>
<td>4</td>
<td>4</td>
<td>0%</td>
</tr>
<tr>
<td><strong>Total number of Foundries</strong></td>
<td><strong>270</strong></td>
<td><strong>265</strong></td>
<td><strong>170</strong></td>
<td><strong>- 36%</strong></td>
</tr>
</tbody>
</table>
Table 4. Estimated annual foundry production by metal type in South Africa (SAIF, 2015).

<table>
<thead>
<tr>
<th>Metal Type</th>
<th>EST. annual production 2003 (tons)</th>
<th>EST. annual production 2007 (tons)</th>
<th>EST. annual production 2012 (tons)</th>
<th>EST. annual production 2013 (tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum</td>
<td>66,000</td>
<td>77,800</td>
<td>21,000</td>
<td>22,000</td>
</tr>
<tr>
<td>Brass</td>
<td>9,000</td>
<td>8,200</td>
<td>Copper Based</td>
<td>14,300</td>
</tr>
<tr>
<td>Bronze</td>
<td>6,000</td>
<td>7,600</td>
<td></td>
<td>9,100</td>
</tr>
<tr>
<td>Zinc</td>
<td>3,000</td>
<td>4,200</td>
<td>1,400</td>
<td>900</td>
</tr>
<tr>
<td>Grey Iron</td>
<td>110,000</td>
<td>147,000</td>
<td>161,000</td>
<td>155,000</td>
</tr>
<tr>
<td>Ductile Iron</td>
<td>100,000</td>
<td>86,000</td>
<td>59,000</td>
<td>47,000</td>
</tr>
<tr>
<td>Other cast iron (White Iron)</td>
<td>85,000</td>
<td>145,600</td>
<td>54,000</td>
<td>28,500</td>
</tr>
<tr>
<td>Steel</td>
<td>123,000</td>
<td>179,100</td>
<td>118,000</td>
<td>106,000</td>
</tr>
<tr>
<td>Stainless steel</td>
<td>4,000</td>
<td>4,900</td>
<td>5,800</td>
<td>6,500</td>
</tr>
<tr>
<td><strong>Total annual production</strong></td>
<td><strong>506,000</strong></td>
<td><strong>660,400</strong></td>
<td><strong>416,500</strong></td>
<td><strong>375,240</strong></td>
</tr>
</tbody>
</table>

Figure 4. Skills base in the South African foundries (NFTN, 2015).
This figure above further indicates the dependency of foundries on skilled workers. It is also evident that trades like pattern making require highly skilled and focused labourers as subsequent activities depend on the accuracy of the pattern made. Fifteen per cent of labourers are qualified pattern makers, however this number could easily be doubled to strengthen local foundries’ competitiveness (NFTN, 2015). The presence of 55% of moulders and 30% of smelters suggests availability of qualified individuals at any given point.

2.7.1 The importance of South African foundries in developing students

The best action any government can take is to draft laws and regulations which will favour local manufacturing sectors and boost the economy for the benefits of its own people. The South African foundry industry continues to contribute positively to the country’s economy. Challenges continue to press down on the industry, but a direct employment amount of 10,285 was recorded in 2014 (Jardine, 2015). This figure is down by 1 080, or 10% since 2011, and will decrease if the same challenges remain.

Eighty percent of these employees comes from previously disadvantaged backgrounds. It was estimated in 2014 that 4 000 indirect employees added value to products, with about 80 suppliers servicing the foundry industry with products and services. The manufacturing industry contributed 13.9% to the 2014 GDP, where a third of this 13.9% was contributed by the metal industry (Jardine, 2015).

2.7.2 Challenges in the South African foundries

There are many challenges facing the foundry industry in South Africa. Some of the challenges have been highlighted to the relevant government departments by different organisations. They include: lack of competitiveness (import leakages and decrease in orders), a continuous rise in energy costs which leads to energy-saving projects, lack of skills development and training, environmental regulations and penalties, availability and cost of metal scrap, lack of financial capital, and the need to keep up with ever-changing technology (Dewhurst and McMurtry, 2006).

Steve Jardine from the national foundry technology network presented five main challenges faced by the foundry industry in South Africa. As seen from other BRICS countries, skills development and training remain the main challenges facing the foundry industry, as shown in Figure 5 (Juganan and Paterson 2012).
2.7.3 The future of the South African foundry industry

Philip (2012) indicates that South Africa has approximately one technologist per 2110 citizens, a figure far below those of countries like Germany and Japan. Philip's findings further claim that 58,140 people worked as engineering technicians without the required qualification. This could be attributed to students in the national diploma level finishing their course work without placement for training (Morgan and Turner 2000). The industry cannot dictate the performance of the global market but there are certain factors and areas which can be improved to position it in a better and more favourable state to boost and move the economy forward (Ayarkwa et al., 2012).

The foundry industry will remain for many more years to come, despite the challenges currently faced. Foundry employees have seen and acknowledged the challenges facing the industry. Alfred Spada, the Marketing and Public Relations Director of the American Foundry Society reported at the 2013 South African Metal Casting Conference, held in the North West, that the challenges faced by foundries in South Africa are not unique in the global context, and that the industry growth will mainly come from foundries, as it is expected that they pay closer attention to the needs of their own customers (Ghosh et al., 2011). "One of the greatest strengths of the foundry industry is that there are so many variables in the process and the ability..."
to find great solutions for our customers is almost infinite. As an industry, we need to actively look for opportunities to show our clients where castings can improve their manufacturing processes, efficiencies and/or costs,” (Juganan and Paterson 2012, p.6). The SAIF and the NFTN have worked on these areas, as indicated below.

2.8 Other training in the local foundries

2.8.1 Learnership Pilot Programme
The South African Institute of Foundrymen, with the support from the South African Qualification Authority initiated and credited artisan skills for smelters, patternmakers and moulders in 2003 to close the gap identified (Kundasami, 2007). Skills shortage has been on the top list of challenges discussed in meetings where the NFTN funded this project with the participation of foundries. The learnership pilot project was initiated with 18 learners in 2010 and 14 learners completed the qualification in 2013 (Davies, 2016). The NFTN completed a feasibility study in the Johannesburg area, which led to the establishment of the Gauteng Foundry Training Centre (GFTC) in Springs, together with the Gauteng Department of Economic Development (GDED) and other partners (Davies, 2016).

2.8.2 NFTN / SAIF Short Course Technical and Skills Training
The eight-module training course was established in the Western Cape in the Nineties by SAIF. The NFTN and SAIF have helped in rolling out the eight-module training course and other short training programmes to the foundry industry. Six hundred and sixty-three learners have attended these programmes and diplomas have been presented to candidates who successfully completed at least six of the eight modules (Davies, 2016).

2.8.3 New foundry generation forum (NFGF)
The new foundry generation forum (NFGF) was started in 2013 to help young and energetic employees in the local foundry industry which is a programme of the national foundry technology network (NFTN), a project by the Department of Trade and Industry (DTI). Through the new foundry generation forum, the aim is to prepare and grow the next group of foundry influential leaders through the provision of a neutral platform, where these leaders can network and engage with each other to address problems faced by the foundry industry (Davies, 2016). The programme
plans to train and allow young leaders to participate in the programme, with the hope to expose the young talent to designs and logical thinking of foundry people around the world so they can understand and deliver services and products exceeding customer expectations. In 2014, a group of candidates completed the programme by presenting the work done as projects. The foundry industry is fully committed to supporting candidates with projects and possible employment (Davies, 2016).

2.9 Employer expectations from students
As markets get tougher and tougher, surviving is becoming more and more difficult for any size of foundry in South Africa. Piva and Vivarelli (2009) suggest that due to continuous change in markets and customer expectations, employers have also shifted their expectations from graduates and permanent employees. Larsen et al. (2009) reveal that employers expect more than they used to expect from graduates and employees a few years back.

Morea (2011) states that some of the personal traits employers are looking for include: a willingness to learn more, a wider skill set, teamwork abilities, problem-solving abilities, to name a few. Some employers believe there is a bigger gap that universities and other tertiary institutions could cover to help graduates integrate smoothly into the work environment (Morea 2011). The most preferred quality for an employee to have was effective communication skills and creative thinking (Viera, 2010). Nine out of ten employers accepted that they are asking employees to take on more responsibilities and use a different set of skills to complete duties than what they used to in the past.

2.10 Value added by students to foundries
It is always said that people who work smarter have a greater chance of achieving more with less resources (Hassan and Shiratuddin, 2004). Students who go to work to only complete their practical training and get paid are usually headed for more challenges than imagined. Morgan and Turner (2000) suggest that those who focus on their duties and constantly look for ways to add value to the company are always ahead of the rest. Some foundries have seen value added by students, while others believe there is little or no value added. It is, however, difficult to quantify the value added by students to the foundry industry.
2.11 Chapter conclusion
Training and skills development remain the main challenges for many foundries around the globe. Literature indicates that there will always be a gap in skills development in the South African foundry industry. The SAIF and NFTN have developed programmes to train foundry workers and provide opportunities for graduates to complete training. Foundries, universities and students need to work together towards reducing the training gap.
3 Introduction

This chapter details and describes the factors contributing to the research design and methodology which were employed in this study. Under this chapter of the research, the method used for the study is discussed in detail. This method explains and validates the choice of the research methodology used and the fundamental concepts. From then on, the following topics will be discussed in detail: data collection, data recording, research procedure, validity and reliability, ethical considerations, and data analysis.

3.1 Research design

The research method used in this study consisted of the gathering of statistical data through interviews, document review and expert review. Statistical graphs were used to indicate scores, frequencies and rankings. Sekaran and Bougie (2013) define the design for research as a plan for collection, measurement, and analysis of data based on the developed research questions of the study. A research design which ensures that sufficient data were collected, to understand the main reasons why foundries do not take students for in-service training, was adopted.

A quantitative research method was considered appropriate as it is a commonly used method to answer questions using mathematical methods (O’Leary, 2010). Using this approach, it was possible to accomplish research objectives by gathering numerical data and reviewing the data using mathematical approaches (Merriam, 1988). Based on the number of foundries in South Africa and the potential of employing students, 52 different foundries within the research setting were selected for the research study. In-depth interviews were conducted face-to-face with foundry management and some industry experts. The interview explored many different views and observations of the local and global foundry market where plans to manage the negative effects of the challenges on the industry were explored.
3.1.1 Descriptive Study
A descriptive study is usually designed to describe a situation or research by collecting data. The data collected were aimed at describing the lack of in-service training in foundries and the impact thereof. Due to the nature of data collected, the research was based on a quantitative approach. Interviews were conducted face to face with foundry managers and foundry owners who were available to take part in this research.

Interview questions mainly focused on determining their understanding of in-service training and to find out the most common causes of lack of in-service training. Document review was also employed to ascertain if training is documented and implemented accordingly. These methods resulted in hard data being obtained from different respondents which led to specific recommendations.

3.2 Study setting and Interference
There was minimal interference to the flow of events when gathering data from foundry managers and supervisors. Ready prepared questions were used during interviews as the best method of data gathering. These interviews and document review were conducted during lunch breaks. Work activities proceeded as per normal during the data collecting process, a type of process that is classified as non-contrived or a field study setting (Saunders, 2003).

3.3 Research Strategy
Research strategy is a method that assisted this study to explore the research topic. As explained by Saunders (2003), research strategy is an idea that helps the researcher to work systematically to answer research questions. Sekaran and Bougie (2015) also state that research strategy indicates why a researcher employs certain research techniques to effectively achieve research goals. It was important to collect enough data for analysis and which could be used to support this study (Saunders, 2003).
3.4 Data collection methods
Data are normally collected from two different sources, which are primary and secondary sources (Sekaran and Bougie, 2015). This research looked at both primary and secondary sources using interviews, document review and expert review. Data were collected from senior managers and training departments. The reason for selecting foundry management and training officers was that they held valuable information on criteria used to recruit as well as the reasons for whenever no training was provided (Sekaran and Bougie, 2015).

The three methods (interviews, document review and expert review) used to collect data were chosen to have the full participation of top management, training departments and a technical team at each foundry and to ensure triangulation of data. Data collected using these two different techniques were analysed using statistical controls such as frequency and rankings. Graphs, tables and diagrams were used to indicate research findings.

3.4.1 Interviews
The use of interviews as a data collection technique was started by choosing the correct candidate known to be more knowledgeable and able to offer more positive information for the research (Sekaran and Bougie, 2015). In this study, a structured interview was employed as one of the methods to collect data, where a carefully worded questionnaire was administered (Kothari, 2003). Table 5 reflects the design of interview questions in appendix A.

Ten structured interviews were conducted with supervisors, work managers, financial managers and general managers for their views on local foundries and the importance of training students. It was important to get views from top management face-to-face, because of their wealth of information and ability to use previous experience to compare current market status and somehow draw an imaginary straight-line projection on the future of the foundry market.
<table>
<thead>
<tr>
<th>Question Number</th>
<th>Possible Problem</th>
<th>Possible Questions</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>There are challenges linked to the implementation of more effective work-integrated learning.</td>
<td>Are you satisfied with your company's policy regarding the number of students given training opportunities each year (strongly agree – strongly disagree).</td>
<td>Van-Schoor and Erwee (2000)</td>
</tr>
<tr>
<td>2</td>
<td>Lack of in-service training and education in foundries is a global challenge.</td>
<td>Are local foundries aware of the importance of training opportunities to students and their career?</td>
<td>Smith (1980)</td>
</tr>
<tr>
<td>3</td>
<td>In recent years, a significant drop in the number of students partaking in training has been recorded.</td>
<td>This foundry always offered students training. The number of in-service trainees has decreased in recent years (strongly agree – strongly disagree).</td>
<td>Mtombeni (2006)</td>
</tr>
<tr>
<td>4</td>
<td>South Africa needs to develop training strategies which will be effective in closing the gap in skills development.</td>
<td>This foundry has actions in place to play the part and reduce the gap in skills development because there is value added (strongly agree – strongly disagree).</td>
<td>Nenzhelele (2014)</td>
</tr>
<tr>
<td>5</td>
<td>Staff training is very important for all employees and productivity in the workplace.</td>
<td>In the last six months, this foundry trained some employees for skills development. (strongly agree – strongly disagree).</td>
<td>Sithole (2009)</td>
</tr>
<tr>
<td>6</td>
<td>Companies that invest less in skills development often have employees who are less motivated and enthusiastic about achieving set goals</td>
<td>This foundry ensures that employees and students are kept motivated throughout the year (strongly agree – strongly disagree).</td>
<td>Yong (2003)</td>
</tr>
<tr>
<td>7</td>
<td>Some of these challenges are beyond the control of foundry managers and foundry owners.</td>
<td>Government is playing a big enough role to help foundries with challenges that prevent them from promoting skills development (strongly agree – strongly disagree).</td>
<td>Jardine (2015)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td></td>
<td>China was faced with three major challenges, which also include training and skills development.</td>
<td>South Africa could compete with China and rest of the world if they had the proper skills development channels (strongly agree – strongly disagree).</td>
<td>Libo (2015)</td>
</tr>
<tr>
<td>8</td>
<td>In India, skills development remains the top challenge facing the foundry, however, the government is supporting the “Make in India” campaign</td>
<td>South Africa must copy India and other countries that support their own locally produced castings.</td>
<td>Indian Foundry (2015)</td>
</tr>
<tr>
<td>9</td>
<td>This challenge has negatively affected training and education</td>
<td>Factors such as lack of funds influence negatively on training and development (strongly agree – strongly disagree).</td>
<td>Brazil Foundry Industry (2015)</td>
</tr>
<tr>
<td>10</td>
<td>Lack of skills development and training.</td>
<td>Is it possible for local foundries to work together and improve the situation to move the industry forward?</td>
<td>(Juganan and Paterson 2012)</td>
</tr>
<tr>
<td>11</td>
<td>Training is the vital tool for motivating employees and increasing productivity in the workplace.</td>
<td>Do you think this foundry can afford training next year? (strongly agree – strongly disagree).</td>
<td>Malone et al. (2000)</td>
</tr>
<tr>
<td>12</td>
<td>There are more factors contributing to the lack of training in engineering students.</td>
<td>How would you rate factors such as budget, training awareness, government support, technical knowledge etc. from main to least contributor?</td>
<td>Jardine (2015)</td>
</tr>
</tbody>
</table>
3.4.2 Document review
Existing records provide insights into more valuable information without observing or interviewing people (Gay and Diebl, 1992). This information is often stored in document form (Cooper and Schindler, 2006). At each foundry, training records and training policies were reviewed. It was also important to look at training programmes to see how many foundries planned training for workers. Understanding the management of the documents and their training record indicated a clear training plan from top management.

To ensure the validity of this research, triangulation of data was used as a method of validating information collected from the three different methods. Surveys, interviews, and document review are very important methods of data collection chosen. The purpose of triangulation is not only used for cross-validation of data but also to capture different views of the same topic under study (Sekaran and Bougie, 2015).

3.4.3 Expert review
Expert judgement on the methodological choice used in this study and the choice of input data used was important as part of three methods used to gather data. An expert with years of experience in the foundry was consulted to discuss research findings. The goal of expert judgement in this study was to assist with the best way to interpret results and to make judgement of the collected data, based on experience in the foundry industry.

3.5 Sampling size
It is important to maintain generalizability and repeatability of data collected by identification of correct sample size. Using a minimum sample size formula below as explained, from a pool of 100 potential foundries to offer in-service training in Gauteng and Kwa-Zulu Natal, 52 different foundries were selected for data collection, with a confidence level of 90%, a margin of error of 8% and 50% response distribution (Leedy and Ormrod, 2005).

This approach was much quicker and data collection was done within two weeks, using questionnaire Appendix A. Table 5 shows questions drawn from the literature review with reference to the design survey questionnaire in Appendix A. These were
questions sent out and some were answered online, whilst others were administered in person.

\[ n = \frac{\left( Z^2 \ast P(1 - P) \right) / e^2}{1 + \left( Z^2 \ast p(1 - p) \right) / (e^2 \ast N)} \]

Where:

\( n \) = sample size

\( Z^2 \) = z-score =1.65

\( N \) = Population size =100

\( P \) = Population proportion =0.5

\( e^2 \) = desired margin of error (expressed as a proportion) =0.08

### 3.6 Measurement and measures

After data are collected from the two different data collection sources, these data were coded, keyed in, and edited. This meant that data were categorized before being typed in to separate outliers and to eliminate inconsistencies and blank answers. Interview questions used were coded to facilitate the entry of the responses directly into a computer without any need to manually type all responses. Data collected were mostly nominal data and very few were interval data. Frequency distributions and percentage distributions were used.

### 3.7 Goodness of measure

The two most critical characteristics of any measurement technique are reliability and validity, and results in a more effective study (Creswell,1994). There are many factors to consider when coming up with a well-structured report that is valid and reliable. This section covers the two most important factors.
3.7.1 Validity
Validity is defined as the "best available approximation to the truth or falsity of a given inference, proposition or conclusion." (Kerlinger and Lee, 2000:14). In short, it is a tool used to ensure that the research is designed to measure that which was initially set out to be measured and not anything else. A minimum number of 52 foundries to complete the questionnaires was identified. Some questions were asked twice, in different ways, to determine validity and reliability (Leedy and Ormrod, 2005). In this study, face validity was deemed a relevant tool to test the validity of the research, where questionnaires were analysed by foundry experts, to ensure that the set-out goals were achieved.

3.7.2 Reliability
Roodt and Fouche (2004) indicate that reliability determines consistency of a measure or score. Reliability is assessed in three different ways, and the most commonly used form for this study is test-retest reliability (Silverman, 2000). It is measured by having the same set of respondents complete the same set of questions at two different times to see how repetitive the answers are. In this study, however, there was not enough time to repeat the same questions but similar types of questions were asked at the same time.

3.8 Ethical considerations
The factors described below were considered as important in order to show good ethics. Research ethics ensures proper the behaviour researchers should display when undertaking research projects (Kerlinger and Lee, 2000). Prior to taking part in this study, the researcher and participating foundries agreed on the commitments and responsibilities each party had to play. Using recommendations by Kerlinger and Lee (2000), the researcher focused only on those factors that were important to participating foundries and the industry at large. It was clearly stated to participating foundries that their contribution was solely voluntary.
3.8.1 Confidentiality
The data collected from each foundry were treated with strict confidentiality and remained so between the researcher and the foundry.

3.8.2 Informed consent
The identified foundries were asked for permission to gather data as designed and were also notified of the precise purpose of the data.

3.9 Questions used during interviews
Over the years, methods and techniques have been developed to measure character and personal traits (Kerlinger and Lee, 2000). A quantitative measure is used to translate personal traits, behaviour and attitude for analysis. To deal with this challenge, a procedure to measure scales was developed (Kerlinger and Lee, 2000). These scores were used to answer closed-ended questions: strongly approve (1), approve (2), undecided (3), disapprove (4), and strongly disapprove (5). A Likert scale was employed for designing proper and well-structured closed-ended questions.

3.10 Chapter conclusion
The research design and methods used in this study have been explained in this chapter. The population and sample as well as reliability and validity were clearly delineated. The role of the researcher, data collection strategies as well as inductive data analysis was also clarified.
Chapter 4
Results and Analysis

4 Introduction
This chapter presents the results of the data collected from interviews conducted with the participants and the reviewed documents relating to training policy. The data were collected and analysed to investigate the participants’ understanding of the lack of in-service training and the effect it has on the number of metallurgical students graduating each year. Expert review of the data was conducted to complete triangulation of information. The data aimed to answer all questions posed to the 52 foundries using the minimum sample size formula, as outlined in Chapter three. The statistical analysis was based on the actual data collected from the participating foundries’ answers to the interview questions. Three types of questions were used during the interviews, namely, closed-ended yes/no questions, a five-point Likert scale, and questions with a structure outlining the most to least contributing factors. These questions were all designed to determine the participants’ understanding of in-service training and the factors contributing to the lack thereof.

4.1 Respondents’ background
4.1.1 Levels of each respondents in their organisations
The aim of the first general question was to determine the level of all respondents in the organization. Interview questions were designed to gather information from employees at the floor level, to top management to avoid bias. Referring to Figure 6, all five available options were represented. Results indicated that 40% of respondents were in senior management positions, 27% were engineers, mainly metallurgists and 21% were owners of foundries, as shown in Figure 6. This showed how inclusive all respondents were and their input was a representation of the understanding of all employees on all levels.
4.1.2 Respondents and their departments

Foundries are known to be technical work places where the production and technical team often play an important role in making decisions. The results indicated that 79% of all respondents worked in the technical or production department while 8% or less worked in the finance, human resource and training departments, as shown in Figure 7. These results were deemed satisfactory as the technical team often conducts production meetings and makes decisions that keep foundries running daily. Also, information collected showed credibility as the technical team operates where casting activities take place in the foundry. This data agreed with the findings of Jardine (2015), which indicated that at any given foundry the technical department often makes decisions that keep the operations going and these decisions are based on experience.

Figure 6. Designation of each respondent in their organisations
4.2 General Foundry Questions
All respondents were asked simple and general foundry training questions and were required to answer yes/no in the next five interview questions.

4.2.1 Importance of in-service training
This first question asked aimed to identify whether respondents were aware of compulsory in-service training for students at universities, to complete the three-year undergraduate programme. This question was also important for the interviewer, to help him channel the interview process in a manner that would suit the interviewee. Figure 8 indicates that 76% of respondents were aware of the importance of in-service training. This is a rather large proportion of respondents that are aware of the need to have in-service training available for students. These findings may seem to suggest that the training challenge might not be that big, however the goal is to get every foundry involved in training and skills development, as suggested by Smith (1980).
Figure 8. Importance of in-service training as understood by respondents.

4.2.2 Opportunities to students
Understanding of the importance of in-service training often comes with responsibilities to offer those opportunities to students. This question was asked to determine if foundries offered training to students to assist them in graduating. According to the research conducted, 71% of respondents indicated that, in the past, their foundries had offered training to students, as shown in Figure 9. This finding indicates that foundries were previously willing to help students and retain some of them to contribute positively to the foundry industry. This suggested that there were more opportunities available in the past than there are currently.
Figure 9. Training opportunities given to students in the past.

4.2.3 Budget for in-service training

It was important to continue probing for a clear understanding of foundries and their attitude towards in-service training for students. The approval of a budget to cover training costs is often an indication of the commitment of foundries to skills development. A large proportion (75%) of respondents indicated in the interviews that to their knowledge, there was no budget allocated for training of students every new financial year, as shown in figure 10 below. This finding shows just how much work needs to be done to highlight and overcome this challenge faced by foundries. The success of foundries working with relevant stakeholders (government and universities) could bring them one step closer towards a long-lasting solution for the industry and students.
4.2.4 Skills development for global competitiveness.
The local foundry industry needs to understand the importance of competing with big players in the game, and skills development is one of the tools needed to bridge the gap. This question was asked to gain an understanding of how the industry viewed training and skills development to sustain foundries and the industry for improvements to compete globally. The results of the interview indicated that 80% of respondents believed that skills development and training could benefit the local industry and render it more globally competitive, as shown in figure 11. This finding agrees with the study by Jardine (2015), which states that South Africa needs to invest in training and skills development to compete with big players around the globe. This also suggested that government and other relevant stakeholders of the foundry industry should increase their efforts and resources in boosting and benefiting foundries.
4.2.5 If this foundry never had to pay students, would they offer training?

The financial wellbeing of these foundries plays a very important role in providing training for students and it was necessary to establish if this factor was the stumbling block towards successful training. The study revealed that 85% of participants said that they would offer training to students if financial responsibilities were to be taken care of by someone else, as shown in figure 12. This finding means that by ensuring that financial support is available, the industry would be one step closer to coming up with a permanent solution to this problem. Once again, this finding agrees with the reports by Jardine (2015) on financial challenges faced by local foundries. This further means that foundries prioritise other financial obligations before training and skills development. Only few foundries are able to go the extra mile and ensure that funds are available for training. This is often done with the help of government in the form of training programmes and placement of students at different foundries.
Figure 12. Foundries that would recruit students each year if they never had to finance the training.

4.3 Five point Likert Scale
Section “B” of the interview questions was designed using the five point Likert scale method from 1 – Strongly disagree, 2 – Disagree, 3 – Neutral, 4 – Agree, 5 – Strongly agree.

4.3.1 You are satisfied with company policy on training
Figure 13 displays the first Likert scale question regarding the satisfaction of respondents with foundries and in-service training policy. It was important to ask this question to get to understand how respondents viewed the way management enforced training by introducing a training policy. The results indicated that 65% of respondents were not satisfied with their companies and reported an absence of in-service training policy. These results mean that foundries also need to play an important role in introducing and amending training policies, to show their commitment to narrowing the lack of in-service training gap.
4.3.2 Government is playing a big enough role in helping with in-service training.

It was important to gather information about how local foundries view the role played by government in ensuring the survival and growth of the industry through support of in-service training, by providing financial and logistical resources. Referring to Figure 14, one can see that 65% of respondents believed that government was not playing a big enough role in helping students with in-service training. The results do not necessarily reflect the actual input from government through training and development programmes already in place. This however means that some foundries are not aware of efforts and programmes already in place at some foundries. The results also mean that there are always possibilities for extra resources from the government to help foundries ease some of the financial strain recently facing the industry.
4.3.3 Management is working hard to help with in-service training.

Figure 15 shows that 66% of respondents indicated that top management was not doing enough to help at least one student per year with in-service training. This question was asked to determine if respondents in the lower rankings believed that top management could do better in ensuring that in-service training is provided. This analysis means that within a foundry, the drive towards improved opportunities for training and development should be encouraged and supported by top management. This includes ensuring partnership with relevant stakeholders for funds and other resources needed. Efforts by top management will always be clearly visible and felt by all employees.
4.3.4 Employees were trained in the last 6 months.
The level of commitment of a foundry to skills development and training is often seen through their actions and investments made. This question was asked to see how much foundries were committed to in-service training and training in general of their own employees. As can be seen in Figure 16 below, only 31% of respondents indicated that the foundries offered training to their employees as part of skills development. This result means that 69% of foundries were not able to offer training to any students in the last six months, which is another step in increasing the number of students looking for training. With the increasing numbers of students in need of training, more efforts to introduce additional partnerships with foundries to alleviate this challenge, are needed.
4.3.5 South Africa could compete with the rest of the world.
The main purpose for skills development and training of local students and employees is to empower the industry to compete globally with big players like China, India and Germany. It was necessary to ask this question to all respondents to determine confidence in local foundries, compared to what the rest of the world is doing. As Figure 17 shows, 57% of respondents believed that local foundries could compete globally if training and skills development was given priority and resources made available. The results are in accordance with findings by Jardine (2015) which indicate that local foundries have hope that, with proper training and development, South Africa will be able to defend its market share in the global foundry economy.
Figure 17. Respondents who believe local foundries could compete globally if training and skills development was given priority and resources made available.

4.4 Ranking factors
Respondents were asked this ranking question to compare a list of different possible contributors to the lack of training in order of importance, with number one being the most important factor to number ten being the least important factor. Drawn from literature review, this list of factors helped participants decide from what they have seen in the past and what they believed were the most important factors contributing to lack of in-service training. It was important to ask this question to identify factors that need attention moving forward. Figure 18 shows Pareto results from 52 respondents who ranked these factors against one another, from 1 to 10, and responses were combined to make this graph.

The graph reveals that the main contributing factors were budget, lack of government support and lack of training awareness. This analysis indicated that the main three factors mentioned above contributed 71% of the problem. The graph also shows that progress can be made, should there be plans in place to address the lack of training. These results confirm some of the findings by Janneker (2006), that posit that budget was noted as one of the main contributing factors that needed attention from government and universities.
4.5 Rating factors

After ranking these possible factors from the most important to the least important, it was necessary to find more information to understand how respondents viewed each as a challenge on its own. A rating technique was introduced, where respondents were asked to rate the same factors using the same common scale from 1 to 10, where 1 was most important and 10 the least important. Answers to these factors were grouped between 1-4 and 5-10 and the total number of each group was established from respondents as displayed in Table 6. The table reveals some unique findings from respondents, where some factors were rated differently as compared to the first data collected when each factor was rated separately. These differences will be highlighted below and the top three factors will be explained in detail.
Table 6. Factors grouped from answers by respondents

<table>
<thead>
<tr>
<th>Factors</th>
<th>Factors rated between 1-4 in %</th>
<th>Factors rated between 5-10 in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Budget</td>
<td>83%</td>
<td>17%</td>
</tr>
<tr>
<td>Lack of government support</td>
<td>75%</td>
<td>25%</td>
</tr>
<tr>
<td>Lack of training awareness</td>
<td>75%</td>
<td>25%</td>
</tr>
<tr>
<td>No external or private funding</td>
<td>38%</td>
<td>62%</td>
</tr>
<tr>
<td>Lack of student commitment</td>
<td>19%</td>
<td>81%</td>
</tr>
<tr>
<td>No value added by students</td>
<td>19%</td>
<td>81%</td>
</tr>
<tr>
<td>No confidence in universities’ standard of learning</td>
<td>15%</td>
<td>85%</td>
</tr>
<tr>
<td>No training department at our foundry to monitor training process</td>
<td>13%</td>
<td>87%</td>
</tr>
<tr>
<td>Students lack basic technical knowledge</td>
<td>10%</td>
<td>90%</td>
</tr>
<tr>
<td>This foundry is not interested in training students</td>
<td>10%</td>
<td>90%</td>
</tr>
</tbody>
</table>

4.5.1 Budget

Budget was rated first and Table 6 shows results and the percentages of the ratings. Eighty-three per cent of respondents rated between 1 and 4 of the rating scale, with the balance of 17% spread uniformly between 5 and 10, as shown in Figure 19. The results mean that 83% of respondents believe that budget on its own is a highly contributing factor to the lack of in-service training in foundries. This further confirms the report by Dewhurst and McMurtry (2006) that discusses the economic challenges facing the manufacturing industry and their likely effects. In their report, Juganan and Paterson (2012) further emphasise the importance of financial and technical support to the industry to improve skills development and training.
Figure 19. “Budget” was rated from 1 to 10 by all respondents.

4.5.2 Lack of training awareness
Another factor that needed close attention was “lack of training awareness” to foundries. This included the awareness and the role that foundries could play, not only for knowledge improvement, but also to assist at least one student to complete training and graduation. Referring to Table 6 and Figure 20, 75% of respondents rated “lack of training awareness” high in the list, as they believed it to be one of the most important factors. These results contradicted with early questions answered by respondents in Figure 8, as 76% of respondents indicated that they understood the importance of in-service training. One would believe that for 76% of respondents to have understood the importance of in-service training, that there must have been awareness in place. This also means that foundries have an idea of the importance of in-service training, however they do not have the mechanisms and necessary knowledge to go about implementing it. This explains some contradictions highlighted in Figure 8 and Table 6 above.
4.5.3 Lack of government support

Lack of government support is a function of knowledge and information on what the current projects conducted by government entail. This lack of government support does not necessarily translate to financial support but rather broad factors, such as operations, process improvement and protection from increasing costs of raw materials and electricity. The question was also believed to be easily influenced by current affairs and the perceived leadership of the state-owned entities. Most of the respondents also related this factor to the government’s failure to introduce a hefty import tax of cast products from China and India which are delivered in South Africa at a far cheaper cost than the local cost of production per ton.

Distribution of answers from respondents showed 75% of respondents strongly believing that this factor was the main contributor to training challenges, as shown in Figure 21. This means that 25% of respondents believed that the foundries themselves share an equal responsibility of ensuring that they impart skills through in-service training of young students. These are the foundries that have initiated their own training practices and have identified value as one of the technical manoeuvres they need to remain profitable in these trying times. This is in line with respondents’ answers in Figure 11, where 65% believed that government was not doing enough to improve skills development and training of students in foundries. Philip (2012) also

Figure 20. “Lack of training awareness” was rated from 1 to 10 by all Respondents
suggests that to improve and increase the number of engineers, there should be an
evident and well-implemented plan from government and universities.

![Graph showing Lack of government support]

**Figure 21.** “Lack of government support” was rated from 1 to 10 by all Respondents

### 4.5.4 Lack of external or private funding

This factor deals with challenges faced by students and the foundry industry which
are related to funding by external and private organisations. As displayed in Table 6,
38% of respondents indicated that they believed this issue to be the strongest
contributor, as they rated the factor between 1 and 4, while the rest are distributed
uniformly between 5 and 10. Further analysis of the results showed a uniform
distribution of responses, which indicated a strong belief that this is not a factor to be
concerned with, as 62% raised no problems with this factor. The number of
respondents indicating fewer concerns about this factor illustrates that some
foundries have financial challenges, but still believe this challenge not to be an issue
necessarily. It also illustrates that awareness and clear procedures are in place for
them to follow whenever they need to assist students.
4.5.5 No value added by students
Some foundries expect students to fast-track their own development within days of training and expect them to be able to lead and make decisions that will benefit the foundry. This expectation often leaves foundry managers with the belief that students do not need time to adjust before value is realised. As can be seen in Table 6, only 19% of respondents rated this factor between 1 and 4, while 81% respondents rated the factor between 5 and 10. This means that only 19% of respondents are concerned about the time needed by students to adjust and be able to add value.

The true reflection of how foundries view this factor is a lot less than what was collected. Further analysis indicated that some foundries do not necessarily understand how training of students is conducted. They believe that anyone coming from university should be able to perform certain duties without experience and this is often not the case, as time to adjust and learn is needed.

4.5.6 No training department in most foundries
Student training is often conducted successfully with the help of training departments that monitor and record performance for reviewing. The Pareto analysis in Figure 17, however, shows that the presence or absence of a training department is not necessarily a contributing factor to the problem of lack of training. This is in line with the analysis in Table 6, where only 13% of respondents were concerned by the absence of a training department at their foundries and rated this factor between 1 and 4. This means that training could still be conducted successfully without a training department, as was supported by 87% of respondents. The observations made by the respondents indicate that foundries are sometimes not able to hire relevant departments, and that foundry managers would often take training responsibilities. It is, however, better to manage the training progress with the help of a training department, as all activities are recorded and rotation of students from one department to another is encouraged.
4.5.7 Lack of student commitment
Students come from different backgrounds and are motivated differently. Their commitment to success is often seen through their daily hard work as they continue with in-service training towards graduation. Only 19% of respondents viewed this factor as the most contributing factor by rating it between 1-4, while the rest of the respondents believed this factor not to be as important and as contributing to the lack of training. The 19% recorded above is a concern, however other factors come to the fore, such as when students are still undecided on whether physical metallurgy is the right career choice for them. Another problem is dealing with younger students, where discipline is an issue, and that often manifests itself through commitment during in-service training. Nonetheless, analysis indicates that most students accept training opportunities gratefully and are willing to see it through to the end.

4.5.8 Foundries not interested in training students
The harsh economic conditions that have been faced by the industry recently forced foundries to prioritise their own survival first. This was evident when respondents indicated that foundries were not interested in going the extra mile to help students obtain training. Referring to Table 6, only 9% of respondents would rather put in extra efforts to ensure the survival of their business. This means that not all foundries are able to accommodate the idea of helping students, due to the uncertainty of their own survival, and these are the foundries that need special attention.

4.5.9 Students lack basic technical knowledge
The foundry industry is by nature one of the most technically demanding industries. This in turn increases expectations from foundry owners and managers of students doing training. Students are often judged by what they have learned in universities as they try to adjust to the pressure of the industry. Looking at Table 6, only 9% rated this factor between 1-4 and believed a lack of technical knowledge in students doing in-service training to be one of the main contributing factors. The rest of the respondents rated this factor between 5 and 10 as a lesser contributor. This analysis indicated that most foundries give enough time to students to gain knowledge in process and products as they start their careers.
4.5.10 No confidence in universities’ standard of learning

Universities are regulated by the Department of Education, where the syllabus is introduced or modified using procedures already in place. Universities use their own study and teaching methods to prepare students for bigger challenges in the industry. Referring to Table 6, only 15% rated this factor between 1 and 4 and believed that universities could do better to improve the standard of teaching and learning.

The University of Johannesburg has a formal process for monitoring their standard of teaching in place and is internationally accredited, and the university has been improving since the merger between the Rand Afrikaans University, the Technikon Witwatersrand and the Vista University took place. There has been also partnership with Germany and the Department of Metallurgy on exchange programmes for Master’s students and this was possible because of the confidence in the university’s teaching standards and its plans for the future. Most foundries do not understand the plans universities have in place, hence the 15% not being satisfied with the standard of learning.

4.6 Document Review.

Document review in this study was used in combination with interviews as part of a quantitative research method and as a means of triangulation in this study (Sekaran and Bougie, 2015). As part of quantitative research, it was expected to draw upon a minimum of two sources of evidence to try to find convergence and corroboration. During interviews, gaps were identified, thus triangulating of data was done, as it would provide ‘a confluence of evidence that breeds credibility and reduce the impact of potential biases that often exist in a single study (Kothari, 2003:6).

4.6.1 Foundries with training documents

The first exercise was to establish if foundries were in possession of documents related to in-service training of students, in order to provide supplementary data. This question was important for collecting general Information regarding the systems in place. Referring to Figure 22, only 8% of 52 foundries indicated that there were documents regarding training of employees and skills development. These findings shed some light regarding the efforts put in place by foundries to help students with training.
4.6.2 Documents related to employee training
A review of documents was deemed valuable, as these add to the knowledge base for training purposes. Out of the 7% of foundries with documents in place, it was important to establish further if those documents were generic, or specifically related to in-service training of undergraduate students. Figure 23 below displays the results of the exercise conducted on 7% of foundries under review. As can be seen, 100% or 8 foundries mentioned training of employees in their training manuals. This means that foundries that have training documents compile these documents with permanent workers and employees as their main primary focus.

Figure 22. Foundries with training documents in place.
4.6.3 Documents related to in-service training of students

Figure 24 below displays the results of the exercise conducted at eight foundries with training documents in place. Four foundries mentioned the training of students in their training manuals. The analysis means that only four of fifty-two foundries had documents which were related to in-service training of students. Less than 10% of foundries visited have training documents, which is alarming and a cause for concern, as no form of controls are in place to monitor and improve the training system.
Figure 24. Foundries with in-service training documents of eight foundries.

4.6.4 Willingness to introduce/update training documents
Well-defined and updated documents often provide a means of tracking change and development in the organisation. Documents need to be managed and maintained as part of a document management system. This means that someone would need to be appointed to be responsible for keeping the documents relevant and up to date. However, not every participant believed in making resources available to achieve this. As seen in Figure 25, 71% of respondents were not willing to introduce training documents and a system in place to help students with training and skills development.
4.7 Expert review

The last method of ensuring triangulation of data to breed credibility in this study was to have an expert of the industry look at the findings collected through interviews and document review.

One of the methods used to triangulate the data collected, was to look at experience of foundry experts that have seen it all and their comments on the findings. The data collected through interviews and documents reviewed were sorted and analysed to extract meaning out of them. The findings were discussed with the former SAIF CEO for insights into the meaning of the data.

The challenge of financial support and budget was not a new one to the SAIF and government bodies, as foundries continued to echo the same challenge year in and year out. Another factor that was no surprise, and which ranked amongst the top three, was the lack of government support and was heard many a time at the SAIF, where foundries indicated their need for support in terms of process improvement initiatives. Foundries constantly raised issues related to the cost of electricity, as well as other main challenges such as the import of castings from China and India.

Foundries believe that government could do more to help but nothing concrete was done and presented to them. The last point discussed was the lack of awareness. There are projects in place, headed by the Department of Metallurgy and the
Department of Trade and Industry in partnership with the SAIF. One cannot hide the fact that more work needs to be done in promoting the training of students at all foundries throughout the country.

**4.8 The trend identified from data collected**

Looking at data gathered from 52 foundries during interviews and document review, it was necessary to analyse it further to pick up some clues or hidden trends on answers. The following were identified as trends from data collected.

**4.8.1 Training documents**

Four foundries showed that their training documents were up to date and made mention of in-service training for undergraduate students. From the four foundries, two were owned fully or partially by the IDC. This indicated that the presence of the IDC ensured that the culture of training students was preserved and improvements were made on existing documents. The other two foundries with in-service training documents in place had foundry managers who were former students from local universities. The influence of these managers was evident in ensuring training was provided, even though these foundries were family owned.

**4.8.2 Size of the foundry and casting output.**

Foundries which are considered bigger (more than 100 employees) with more than 5 000 tons of castings sold per annum, showed that most processes were documented, and some could show some training documents in place. Most of these foundries indicated that they had employed students for in-service training in the past. These big foundries also mentioned how they were open for suggestions and perhaps change and introduction of training policies.

**4.8.3 Family-owned foundries**

Ninety percent of foundries visited were family-owned businesses with from 5 to 300 employees. The focus of these foundries is to ensure the survival of the business, thus in-service training was deemed unnecessary and resource-consuming. Most of the respondents representing this category showed dissatisfaction regarding government institutions. These are the foundries that indicated no confidence in the standard of teaching and learning, and were not impressed with students’ commitment and technical abilities. However, most of the respondents in this group
have decades of experience and are optimistic that improvements and positive movement in the markets will eventually play in favour of students.

4.9 Chapter conclusion
Data collected in this chapter were needed to address the first question above. The bulk of this chapter with figures and paragraphs explained and showed the main factors that needed attention from foundries and government institutions as an attempt to answer the first question. The second question above looked at strengthening partnership between foundries, universities, and government, which will yield positive results and drive development and innovation of new products going forward.

Foundries mentioned a lack of awareness and visibility of government involvement in promoting training on a larger scale. The partnership should be driven from the top with involvement of all universities that produce metallurgical graduates in need of in-service training. All South African foundries should be involved and be given the platform to voice their suggestions on a regular basis to ensure proper involvement and continuous improvement of the system.
5 Introduction
A quantitative study was conducted with an aim to answer the following two research questions which were asked in chapter 1.

A. What are the main reasons for South African foundries not taking students for in-service training?

B. How can stakeholders of this industry work together to promote in-service training?

The analysis of data collected from 52 foundries showed interesting findings and answers to the research questions:

A. The study revealed that there are three main factors that respondents believe contribute to foundries not giving students opportunities for in-service training. In order of importance, these main factors were: budget, lack of government support, and lack of training awareness.

B. It was also discovered that some respondents believe a disjunction exists between universities, government and the foundry industry. This division was believed to have influenced and negatively impacted the number of students who are not able to graduate each year due to lack of in-service training.
5.1 Recommendations
Based on the findings from data collected; the following recommendations were made:

5.1.1 Financial Support and Budget
This factor was rated the most contributing one to the lack of in-service training. It was recommended that the Department of Trade and Industry and the Industrial Development Corporation, together with the help of universities, look at providing extra budget, specifically for students that are searching for training.

This should be done in a way that the foundries that are willing to help, can help, while their focus continues to be on increasing profit and finding other business that will benefit their foundries and help the industry move forward. Foundries that have been proactive and on the forefront of helping students with training should be identified and rewarded for their constant willingness to be of assistance.

5.1.2 Government Support
There are current projects on skills development and training taking place at places such as Mintek, and that have been successful in the last few years and were supported by the Industrial Development Corporation. This indicated the presence and support from government to help the foundry industry. This, however, could be improved by getting all foundries involved. This initiative should ensure transparency and the main purpose should be to get all foundries to know about the plan and to ensure smooth transition, should they wish to be part of the project. The success of the government’s support of the foundry industry should be clearly visible to all parties involved and positive results must be there for all to see.

5.1.3 Lack of training awareness.
This factor was rated one of the top three important factors to look at and to create ways to find solutions to help students graduate. Respondents have indicated that they were not aware of the need for the mandatory one-year in-service training in order for students to complete graduation. Each foundry has the potential to help at least one student at a time and all foundries need to understand this process and how they can help. Universities with the support of relevant departments need to approach foundries and explain the process and encourage them to commit to the project.
5.1.4 Documents Review/Training Programme
Only four foundries were in possession of updated documents related to the training of students. It was recommended to design a training process that will ensure that students are exposed to different departments, in order for them to understand how companies operate and how their hard work can benefit these foundries. The documents need to be clear on what needs to be done and when. This will ensure that students adjust to the training environment and are able to help foundries achieve their goals.

5.2 Summary of the dissertation
The overriding purpose of this study was to determine the factors that play a role in the lack of in-service training of metallurgical students in foundries and to come up with realistic recommendations based on the findings. To achieve these goals, it was important to employ a quantitative study, where questionnaires and review documents were designed and used at 52 different foundries. Expert review of data collected and summarised was conducted with the former SAF president to obtain their views and validation of facts, based on their years of experience. Based on the data collected and analysed, three main factors (financial support and budget, lack of government support, and lack of training awareness) were found to contribute 71% of the problem and recommendations were made based on these findings.
Reference

Abrahams, C. (2014). Governance and institutional arrangements in the manufacturing engineering and related services SETA.


Maya, S. (2014). *Developing an integrated career path with sustainable skills development for engineers: An Eskom Western Cape operating unit case study*. Stellenbosch: Stellenbosch University.


West, C., Duffy, J., Barrington, L., and Heredia, M. (2010). Student voices: 
Service-learning in core engineering courses. ASEE Annual Conference Proceedings. 
Louisville, KY: American Society of Engineering Education.

Publishers Ltd.

training program model: inter-relationship among the three main stakeholders: 
student, university and host company. In the Proceeding of the 2nd Regional 
Conference on Engineering Education (RCEE), December 3-5, Malaysia, pp. 24- 
30.

Yong, K.B. (2003). 'Human resource management'. In Malaysian Institute of 
Management (eds.), Management in Malaysia (230- 250). Shah Alam, Malaysia: 
Percetakan Printpack.

Yorke, M. (2006). Employability in higher education: What it is-what it is not. York: 
Higher Education Academy.
### Appendix

**Interview Questions**

<table>
<thead>
<tr>
<th>TYPE A</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>General Foundry Training</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Do you understand the importance of in-service training for students?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Has your foundry ever given any opportunities to students in the past?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Does management approve budget for training?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Is skills and training part of factors contributing to local foundries being competitive globally?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. If this foundry never had to pay students, would you recruit at least one student per year for in-service training?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### TYPE B - SCALE

Interview questions were organized by a five point Likert scale:
1 – Strongly disagree, 2 – Disagree, 3 – Neutral, 4 – Agree, 5 – Strongly agree.

<table>
<thead>
<tr>
<th></th>
<th>Strongly disagree</th>
<th>disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. You are satisfied with your company’s policy regarding the number of students given training opportunities each year.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Government is playing a big enough role to help foundries with challenges that prevent promotion of skills development.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Management of this foundry is always looking at ways to help students with training.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. In the last six months this foundry trained employees on skills development.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. South Africa could compete with China and rest of the world if proper skills development channels were in place.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TYPE C - SCALE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The questions are scaled from 1-10 (1 being the main contributing factor and 10 being the least contributing factor).</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Budget</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lack of training awareness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lack of government support</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No external or private funding</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No value added by students</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No training department at our foundry to monitor training process</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lack of student commitment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>This foundry is not interested in training students</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students lack basic technical knowledge</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No confidence in universities standard of learning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
</table>