Master of Science Degree in
Mineral Resource Management

POST GRADUATE INFORMATION

Developed with Industry Partners and Implemented by the
University of the Free State

UFS-UV
UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITI YA FREISTATA
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1. INTRODUCTION

External and internal challenges in mining are increasing the difficulty and complexity of operating mines. The external mining environment has a big impact on mining operations and is driving things such as the focus on safety, sustainable mining, green issues, profitability and productivity. There is a very high emphasis on “reducing cost to improve”, lower mining and beneficiation cost by eliminating waste/ineffectiveness (reduce people, use less consumables, multi-tasking skilling, etc.). The internal mining environment is getting tougher to operate in, within each deposit being more difficult to mine, more difficult to manage due to external pressure, issues with maintaining quality, etc.

Technological and environmental developments too numerous to mention mean that cost control models, reduction in human resource numbers, as well as other drastic measures to curtail expenditure and increase profitability have become part of everyday business. The capability to manage the mining environment in a systemic manner has been lacking and this increases the pressure for performance on those individuals operating mines. Working smarter has become crucial to ensure that businesses optimise the use of their resources, become more safety conscience, more productive and to remain cost-effective, while recognising the importance of sustainable mining now and in the future.

These drivers and demands were recognised by The University of the Free State and in partnership with industry partners developed the Mineral Resource Management post graduate qualification to enable students to meet the challenges in mining. The Mineral Resource Management (MRM) practice is based on the amalgamation of mining industry principles and improvement methodologies such as Mineral Resource Management (MRM), Theory of Constraints (Mining TOC), NPV optimisation, Product Payability, Geometallurgy, Value chain optimisation, integration and synchronisation, and mining mineral and product throughput optimisation. MRM is a business practice involving the synchronisation and balancing of material flow and product payability attributes of the mining material flow. The focus of the qualification is on the application of the MRM practice to improve business performance through:

- Establishing a foundation knowledge of all the functional disciplines applicable in the mining value chain
- Expand the knowledge to include the supporting functional disciplines such as implementation, modelling and financial practices
- In all the modules the synchronisation and balancing of the MRM enablers and key drives in material flow and product payability attributes is emphasised though examples and exercises to create a clear understanding of the impact on sustainable EBIT and EBIT growth
- The importance of subordination to material flow and alignment of enterprise resources to operate at optimal material flow is discuss with examples and exercises
Exposure and training to apply MRM and flow tools to investigate and design for optimum throughput is an integral part of the training course.

1.1. WHAT IS THE PURPOSE OF THE MINERAL RESOURCE MANAGEMENT DEGREE?

The MRM practice will enable students to optimise ore-utilisation, product delivery and, thus the profitability of the mining company. Using the principles of the Mineral Resource Management Practice, students will be able to make ‘flow’ decisions based on physical and product payability attributes requirements and utilise their resources and people skills to the benefit of the company and all its various stakeholders. The purpose of the post graduate programme is to equip students with the:

- Understanding of the under-lying principles that are applicable in Mineral Resource Management
- Ability to identify the dependencies, interdependencies and variability that impact flow performance
- Ability to use the TOC thinking logic processes (Current Reality-, Future Reality-, Intermediate objectives- and transition trees)
- Ability to apply the principles of Mineral Resource Management, this is achieved by exposing learners to the theory, case studies and discussions of the detail complexity of mining and other related disciplines that impact the mining value chain
- Ability to use the MRM and TOC tools and logic.

1.2. WHO ARE THE IDEAL CANDIDATES FOR THE COURSE?

The ideal candidates for enrolment in the course are people who want to understand mining as a business process and who want to develop the knowledge how to synchronise and improve the throughput of their mine. The course does not aim to turn mining engineers into industrial engineers or metallurgists into geologists. The MRM course is also suitable for persons working in the project and information technology environments at a mine or head office of a mining company. Candidates would typically be:

- Mining professionals (geologists, surveyors, mining engineers, metallurgists, chemical engineers, industrial engineers, resident engineers, production, marketing and financial managers.
- People who work in the mining environment who have responsibilities in the fields of planning, scheduling and production management with prior learning and work experience
- People working in the information technology environment who consult in systems architecture and implementation who need to understand the mining process and information requirements to provide a better service to clients.
1.3. **HOW IS MINERAL RESOURCE MANAGEMENT MASTERS DEGREE DELIVERED?**

The MRM Masters of Science Degree is presented by the Geology Department in the Faculty of Natural and Agricultural Science at the University of the Free State and accredited by the Council for Higher Education. The course material is delivered to students in three components; course material provided by the university, recommended and compulsory reading and interactive workshop sessions per module. Retention of study material will either be by examination or project assignment depending on the module (Figure 1).

The qualification delivery structure is designed to minimise impact on students. The time away from the office due to class attendance was minimised to mitigate the any disruptive and costly time impact for student when attending structured classes away from their workplace.

![Figure 1: Course component for each module](image)

1.4. **WHAT ARE THE ENTRANCE REQUIREMENTS OF THIS COURSE?**

Figure 2 depicts the entrance requirement for commencing a post graduate study in Mineral Resource Management. Candidates may be admitted if they have a 4-year degree, or post graduate diploma, equivalent to NQF (National Qualifications Framework) level 8 and at least 2 years relevant mining experience.

![Figure 2: Entrance requirement for post graduate study](image)
2. THE MINERAL RESOURCE MANAGEMENT (MRM) PRACTICE

2.1. WHAT IS MINERAL RESOURCE MANAGEMENT (MRM)?

The Mineral Resource Management (MRM) practice is based on the amalgamation of mining industry principles and improvement methodologies such as Mineral Resource Management (MRM), Theory of Constraints (Mining TOC), NPV optimisation, Product Payability, Geometallurgy, Value Chain Optimisation, integration and synchronisation and mining mineral and product throughput optimisation. The need for such a practice can be described as follows:

The mining value chain in mines and across commodities shows a complexity and a management challenge due to dependencies and interdependencies, ore and ore body variability that is not adequately dealt with. The mining environment has the following factual attributes that drive the effective exploitation of a mineral deposit:

1. Numerous dependencies and interdependencies exist between operational resources, mining cycles, plant processing cycles, mining related activities and processes
2. Variability in equipment resources and activity performance exist at any moment as well as over the duration of operational cycles in mining and beneficiation
3. The complexity of these attributes is further enhanced by the following:
   - The fact that physical material flow capacity constraint resources exist within any flow chain
   - The ore, ore body morphology, and waste characteristics in any mineral resource are variable and impact performance output and productivity of the mining value chain
   - The mining processes, mining methods, applied mining method(s) limitations, mining operating culture and decision-making governance rules
4. The plant processing characteristics and methods, plant equipment thresholds, plant processing reagent dosage thresholds and control. The setting of the plant equipment and of the processing reagent dosage levels in respect of the ore and waste characteristics in the plant feed (at a specific moment in time or period)
5. Further variability and dependencies will be introduced due to the above interdependent conditions.

The net result will be a high level of overall complexity. The usual manner to evaluate flow and production capability is to use a reductionist approach (use single numbers which most likely reflect a “on average the most probable achievement” value), however in order to calculate the true flow capability on an operation the above factual attributes must be considered. Additionally, we also need to understand the interdependencies between these facts, the mining economy and social challenges of modern times, such as:
1. Commodity demand and sales price fluctuations?
   - Increase or cut back on production volume
   - Sustainable EBIT and/or EBIT growth
   - Cut back and/or containing of production cost. The implication on total cost and cost/unit produced
2. Necessity to improve efficiencies
3. Safety and social compliance.

The management challenge is to build the flow and product payability logic of the production capability of the mining value chain that includes: dependencies, interdependencies, variability, constraints, ore & ore body characteristics, company management culture and decision-making principles. This logic provides the knowledge, direction and ability to identify the key performance and cost drivers to maximise flow, productivity, product payability, return on reserve, life-of-mine, NPV, and minimise cost/unit produced.

2.2. THE FUNCTIONAL/ENGINEERING APPROACH

South African mines have been kept buoyant by applying stringent cost-cutting measures, particularly over the last few years. In line with international business trends, there is a strong focus on cost-cutting and improving business processes (mostly done in isolation) through re-engineering and other fashionable theories and approaches. The four main focus areas and practices applied to improve EBIT and NPV are the following:

- Focus on functional/departmental excellence (local optima), and ignoring the impact of dependencies between functions and thus the impact on the value chain output
- Use static balanced capacity designs and management principles, and ignoring the combination impact of dependencies and variability in and between resources and activities
- Generate single averaged values (“on average the most probable” situation) for complex variable mining conditions to be used for decision making, without the understanding of the root causes creating the complex situations
- Focus on technology improvement to create functional excellence without the synchronisation of the value chain first and then the application of technology
- The combination of the above will worsen the financial situation and performance.

The above practices and the focus on reducing costs and doing local optimisation, however, are not producing the required results and other means and approaches must be considered. There is a general lack of focus on the increase of throughput, which should be beneficial to the business and the cost reduction approach has been non-effective in mining because it is a high cost and capital-intensive environment. The benefit of these approaches has been limited in improving the cost-effectiveness of day-to-day operations.
The current mining business approach typically focuses on optimisation and cost management of functional environments (local optimisation), viz. mining, plant, geology, maintenance, etc. These functional areas are aligned to establish a business and operational plan. However, the business and information focus are largely functionally based with each function autonomously implementing its particular cost-cutting initiatives. Improvements are therefore in many cases isolated and aligned with the organisational structure. Production, personnel performance, cost improvement, etc. is all measured within the functional business area. Planning and strategy are based on historical factors and averaged data, which do not in any meaningful way consider the current reality and future possibilities.

A limitation of a strong functional approach is a non-alignment of the ore properties and operational flow with the final saleable product. The dependencies and inter-dependencies among variables across functional areas are seldom taken into consideration in the production process. For example, a variable encountered in a specific functional area that may affect the performance of another functional area, may not always be taken into account in the planning and/or the production and/or performance measurement processes. Where such variables are included in planning and budgeting, average norms and standards are mostly used. These norms and standards are often not condition driven or period specific and, as mentioned before, mostly derived from historical data that might not be relevant any longer.

### 2.3. MINERAL RESOURCE MANAGEMENT PRACTICE

Material Flow and Product Payability Attribute alignment involves different activities (independent of functional areas) that have an influence on business flow performance. All variables that affect flow performance must be identified, quantified, planned for and managed on a strategic, tactical and operational level. Through quantifying both production performance and cost variables in term of variation in physical conditions, condition-driven standards that approximate reality more effectively are derived. This approach is in contrast with using average or historical norms and standards as mentioned before. For example, variation in conditions such as the dip of seam contacts (orebody morphology) and ore morphology (chemical composition, mineral associations, hardness, grain size, etc.) would influence production rate, quality of mined ore, beneficiation efficiency, production and maintenance cost and ultimately the stability of the total mining value chain.

The application of the main focus areas for the functional/engineering approach within the MRM environment are depicted in Figure 3 and can be summarised as follow:

- MRM focuses on the value chain output and synchronise the functional/departmental support management rules and protocols to the maximisation of the value chain output.
- MRM uses dynamic flow balanced capacity designs (constraints, buffers, catch-up capacities, break dependencies of complex chains, etc.) and management principles which include the impact of dependencies and variability in and between resources and activities.
- MRM defines root causes and cause & effect logic for variability, dependencies and interdependencies, and develop condition driven standards and protocols to effectively plan, manage and measure at a LOM, NPV, ROR and operational level. Condition driven standards differentiate between mining areas with variable ore and ore body characteristics. Average standards are not used.
- Understanding and effective management of flow constraint resources, root causes of variability and interdependencies and dependencies before the application of technology to support the new business approach is a key practice within the MRM methodology.
- The combination of the above will ensure a stable and predictable value chain performance and maximise LOM, NPV, ROR and EBIT now and in the future.

Figure 3: MRM’s mining extensions to the Functional/Engineering and Theory of Constraints processes
2.4. MINERAL RESOURCE MANAGEMENT IMPLEMENTATION

The implementation process of a Mineral Resource Management Program may be summarised by the following high-level activities:

- Analysing the business to determine the key throughput drivers and constraints in the production process
- Configuring a ‘process simulation model’ (in terms of key drivers) for scenario testing, management and control purposes
- Defining throughput-driven information technology architecture for process and functional needs
- Implementing a value chain synchronisation initiative to create awareness and understanding of the “process throughput concept”, and to empower employees with MRM knowledge and skills
- Training people in the MRM approach so that its benefits can be sustained and improved in the long term
- Identifying the key value chain synchronisation drivers and activities that need to be optimised to enable both an effective throughput strategy and the scope for consulting in the application of the MRM approach in the strategic and operational environments.

2.5. UNIQUE ATTRIBUTES OF MINERAL RESOURCE MANAGEMENT

The MRM methodology enhances the TOC (theory of constraints) approach. It is specifically adapted to suit the mining environment to synchronise and balance the physical flow and product payability attributes of each unique mining value chain. The MRM approach add two key elements to the typical TOC approach of physical flow analysis, that of dependence between ore body characteristics, ore body morphology and the impact of the variance in physical operating conditions by the ore and orebody morphology

- Building a flow and attribute mining value chain simulation model in terms of key drivers, inclusive of CDS
- Planning performed in terms of specific product quality across the total product range
- Real-time decision support for scenario evaluation and economic decision-making
- Creation of a flow-focused “management and control” environment
- Alignment of the operational environment with the strategic environment.
2.6. BENEFIT OF THE MINERAL RESOURCE MANAGEMENT PRACTICE

Based on actual implementation experience, the estimated benefit of the implementation of a Mineral Resource Management programme may be a 2% to 20% increase in revenue and a 5% to 15% decrease in unit cost per annum. The Mineral Resource Management programme will add value in the following areas:

- Improved management and control, ensuring optimal utilisation of the orebody by integrating the mine planning and operational environments
- LOM (life-of-mine) planning by aligning the resource to the market throughout the mining value chain
- Improved Operational management through:
  - Mineral definition and classification
  - Physical flow and product payability attributes indicators
  - Constraint and buffer management
- Improved ore-utilisation through:
  - Scheduling based on material compatibility
  - Extraction through improved control of grades and contamination
  - Utilisation of low-grade ore, classified as discard
  - Improved plant recoveries/yields and product grade optimisation
- Dilution management that improves plant performance; increases product yield and maximise product production
- Improved stockpile and product bed qualities (reduced risk due to under-specification and minimising the deviation in quality above specification)
- Improve LOM, NPV, ROR and EBIT now and in the future.
3. THE MINERAL RESOURCE MANAGEMENT ENVIRONMENT

The main areas in Mineral Resource Management that contribute in the mining value chain are:

3.1. GEOLOGY

The value chain synchronisation and balancing of flow is the most important area which include the ore, waste and ore body morphology. Geology plays an important role in the Mineral Resource Management approach. The role geology is playing in the alignment and synchronisation of the ore and waste characteristics with the plant processing characteristics and thresholds is very important. It is one of the most important focus areas in improving return on investment. The areas that are addressed are:

- Improvement of accuracy of geological information, by reviewing existing information and applying scrubbing and re-evaluation techniques. Information must be throughput focused and aligned with actual conditions
- Optimise ore-utilisation at a strategic level by developing scenarios of LOM (life-of-mine) based on geological alignment across the production value chain
- Optimise ore-utilisation at a tactical level through alignment of strategic and operational geological parameters on the medium term
- Optimise ore-utilisation at an operational level through geological parameter control, such as:
  - Grade and contamination control
  - Optimisation of cut-off grades (through the utilisation of low-grade ore)
  - Ore-utilisation Key Performance Indicators (KPI’s)
  - Ore balance sheet
  - The alignment and synchronisation of the ore and waste characteristics with the plant processing characteristics and thresholds.

3.2. MINING AND STOCKPILES

Understanding the impact of mining methods on ore-utilisation and physical material flow will determine how effective mining operations will be. Secondly the impact of ore, waste and ore body morphology characteristics on effective mining operations. This is achieved through:

- Integrating ore, waste and ore body morphology characteristics, geological modelling, mine planning, beneficiation modelling and final processing in terms of throughput
- Improving contamination control through the management of dilution, and eliminating the inefficient use of high-quality ore through a grade and contamination control system
• Improving ore-utilisation re-conciliation between planned and operational results
• Scheduling in terms of material compatibility and beneficiation potential.

3.3. BENEFICIATION

Understanding the impact of geological parameters, mining methods and ore handling (contamination and fines control) on the beneficiation process will enable improved beneficiation and pro-active control in the mining environment to:

• Alignment and synchronise the ore and waste characteristics with the plant processing characteristics and thresholds
• Increase total product value through the improvement of in-situ information to optimise product grade
• Continuous optimisation of cut-off grades through the alignment of feedstock quality to the required product quality and the identification of opportunities to use cut-off grade feedstock
• Improve recovery versus optimum quality by determining critical ore morphological parameters to be managed during beneficiation
• Improve reconciliation between planned product and actual results through a holistic mineral resource accounting system.

3.4. MARKET DEMAND

The core objective of Mineral Resource Management is to align the mineral ore body with market demand (product tonnage, product specification (quality) and time to deliver). The market demand focus covers the following areas:

- Product quality optimisation (consistent quality)
- Market cycle management and control
- Product stockpile scheduling in terms of the quantity and quality needed by the customer
- Product payability optimisation.

3.5. INFORMATION MANAGEMENT

Technology enablers are an important component for sustainable application of Mineral Resource Management. Although the mining industry has a long history of development and use of specialised production-related information technology, especially in modelling and mine planning of the mineral resource, it is not creating the expected benefits due to a planning focus and not an operational focus. Due to the strong functional-based approach traditionally used, many opportunities are lost because manual manipulation of
information and processes is far easier than following a more rigorous data approach. Critical focus areas in this environment include:

- Alignment of the business system with the operational planning system through the definition of aligned information structures
- Design and implementation of a reconciliation system to enable the tracking and monitoring of production and commercial information, for continuous alignment with the production-planning environment
- An aligned simulation environment to engage in scenario planning, as well as management and control at a strategic, tactical and operational level.

3.6. PEOPLE

A structured and deliberate Change Management practice is required to embed the MRM practice in organisation. Organisational change management ensures that any change in the organisation is accepted and applied successfully to the benefit of all stakeholders. This could affect hierarchies, remuneration, role definitions and profiling. The cross-functional nature of the MRM approach implies that silos are broken down into effective networks. Eventually highly productive teams evolve.

Operational change management will utilise the existing organisational resource base to optimise individual, network and cross-functional disciplines to create competencies within the business to facilitate the process and activity-driven mode of work that enhances throughput. Behavioural change management will assist individuals to understand their personal contribution and impact on the network and bigger production environment. Once the process is understood by learners, they will be able to create a process that develops individuals in their respective environments so that they work effectively and efficiently in a network or a team.

Cultural change management will address issues that impact the culture of an organisation (e.g. to convince the employee base that diversity is an asset and not a liability). Simple processes aimed at establishing a common focus and a supportive business environment that enhances throughput are initiated through established principles that enhance individuals and team’s self-worth.
4. COURSE DETAILS

The post graduate MRM qualification course structure is divided into four phases. The first-phase modules are mandatory for all candidates. In addition to the first-phase, post-graduate candidates have to complete at least 5 of the second-phase modules and two from phase 3, as well as a research essay in phase four. Master’s degree candidates must complete 12 modules before the submission of the research dissertation.

Table 1: The different phases of the MRM course

<table>
<thead>
<tr>
<th>PHASE</th>
<th>DESCRIPTION</th>
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<tbody>
<tr>
<td>Phase 1</td>
<td>This phase introduces the learners to the functional areas in the mining value chain. Its purpose is to equip the learners with the knowledge and an awareness of the different functional areas and their interdependencies. Learners are further exposed to how these interdependencies impact on throughput and business performance.</td>
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<tr>
<td>Phase 2</td>
<td>This phase of the course introduces MRM enablers to the candidates. These include MRM Organisational Change Practices, MRM Implementation Practices, MRM Information Practice, ‘Virtual Mining’ Simulation and Optimisation, Geological Modelling and Geo-statistics and Mineral Resource Management II (Advanced): Grade control, Ore Balance Sheets, Ore Utilisation.</td>
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<tr>
<td>Phase 3</td>
<td>This phase includes financial cost modelling and decision making, risk management in the mining and minerals industry and modern mining supply chain principles.</td>
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<tr>
<td>Phase 4</td>
<td>This phase requires a research essay to be completed. The subject of the study is chosen in consultation with the course co-ordinator. The dissertation must be submitted for formal examination.</td>
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</table>
4.1. THE MODULES OF THIS DEGREE

The modules are listed below in the table; the module number, a short synopsis and the objectives of the module are included. Be aware that presentations, lecturers and training material used during the workshop sessions may change based on new developments and experience in implementing Mineral Resource Management.

Table 2: Modules presented in MSc. Mineral Resource management phase 1

<table>
<thead>
<tr>
<th>Phase</th>
<th>Module No</th>
<th>Synopsis</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GLGA7913/23 (711): Overview of geology, mining, metallurgy and business processes</td>
<td>Introduce learners to the different functional disciplines through an overview of the important principles of Mineral Resource Throughput Management in strategic, tactical and operational environments, each in the different functional areas. The functional areas include geology, mining, beneficiation, marketing, finance, human resources, plant maintenance, planning and scheduling, budgeting, maintenance and supporting processes</td>
<td>To develop an adequate level of understanding in each of the functional areas and the interdependencies between functional areas present in the production environment with specific emphasis on product production, income, costs and market demand.</td>
</tr>
<tr>
<td>1</td>
<td>GLGA7933/43 (712): Mineral Resource Management I (Methodology)</td>
<td>Highlight the principles and methodology of Mineral Resource Throughput Management through the identification and quantification of process variables. The development of a business process concept with emphasis on product delivery, cost, income and market demand for the strategic, tactical and operational environments. Included are strategic evaluation of the long-term environment, as well as management and control of operations in terms of the budget and short-term plan.</td>
<td>To enable learners to apply MRM principles to a business analysis with the purpose of identifying variables and dependencies that impact product delivery. To align the variables through planning and operations processes of the functional areas as a single business process.</td>
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<td>1</td>
<td>GLGA7953/63 (713): Applied Geology</td>
<td>Understand and identify the influence of geological variables in the Mineral Resource Throughput Management environment in terms of the exploitation needs in the long-term and production environments. The</td>
<td>To enable the learner to determine and quantify variables pertaining to ore and ore- body morphology that has a critical influence on product delivery and profit. To equip the learner to structure and apply geological information in the</td>
</tr>
<tr>
<td>Course Code</td>
<td>Course Title</td>
<td>Description</td>
<td>Learning Objectives</td>
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<tr>
<td>GLGA7973/83 (714): Applied Mining</td>
<td>Application of variables and condition-driven standards in mine planning, scheduling and production management and control. Methods to determine the influence of “run-of-mine” quality on plant efficiency and product delivery. Exposure to the quantification, application and relevance of mining information to the production process (beneficiation, stockpile management). Included are the effects of maintenance performance and strategy in terms of condition-driven standards.</td>
<td>To equip the learner to structure and apply information pertaining to different mining conditions and variables in terms of the Mineral Resource Throughput Management approach to improve planning and scheduling. The learner will be exposed to methods to align the “run-of-mine” volume and quality with the plant process, as well as determine the impact of ore and ore body morphology on the budget, economic evaluations and ore reconciliation. The practical application of the concepts in a production environment to optimise and improve income and profit on a daily basis will be emphasised.</td>
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<tr>
<td>GLGB7913/23 (715): Applied Metallurgy</td>
<td>The influence of plant condition and standards on the long-term and production environments, with particular focus on product range, will be examined using Mineral Resource Throughput Management principles. The value of beneficiation information when focussing on adding value to the production process (beneficiation, stockpile management and product specifications) will be highlighted as well as the way in which the information is used to achieve optimum product delivery.</td>
<td>To equip the learner to structure and apply the process variables in terms of the influence on product delivery, production cost and income by using beneficiation information. The learner will be exposed to methods to align the process, process efficiency, plant feed quality, product recovery and optimum yield to determine which critical variables have to be managed.</td>
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<tr>
<td>Phase</td>
<td>Module No</td>
<td>Synopsis</td>
<td>Objective</td>
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<td>2</td>
<td>GLGC7913/23 (721): MRM Implementation Practices</td>
<td>The applicability of project management as a major critical performance area in sustainable Mineral Resource Throughput Management will be examined and discussed. The module will emphasise the practical application of TOC thinking processes in structuring projects on how to deal with the challenges in implementing MRM in a mining operation. Examples and exercises will be presented in the course.</td>
<td>To equip learners to design, implement and operate a Mineral Resource Throughput Management programme.</td>
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<td>2</td>
<td>GLGC7933/43 (722): MRM Information Practices</td>
<td>Availability of flow Information is an important component for sustainable Mineral Resource Throughput Management. This module will examine all the key elements of data structures, recording challenges, validation issues and presentation. The question of information provision to management structures and the timeliness impact on the mining value chain will be examined. Examples and exercises will be presented in the course</td>
<td>To equip learners to understand, identify, implement and manage the flow information environment for the mining value chain.</td>
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<td>2</td>
<td>GLGC7953/63 (723): MRM Organisational Change Practices</td>
<td>Change management is often misunderstood and methodologies are used with little visible return on investment. The reason is that typical training approaches are neither appropriate nor effective within this environment. The subject-matter will be examined and discussed in four broad areas under the heading of enterprise resource alignment. These areas are strategy and guidance mapping, mobilisation, enablement and performance, and competence tracking. The processes methodologies and how they apply within Mineral Resource Throughput</td>
<td>To equip the learner to understand the broad change management issues applicable when implementing MRM. The learner will be enabled to identify critical performance areas of change management, to design a basic change management strategy and learn how to execute that strategy.</td>
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<td>Management will be discussed. Practical and simplistic management procedures to ensure HR optimisation are imparted for continuous measurable results.</td>
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<tr>
<td>2</td>
<td>GLGC7973/83 (724): ‘Virtual Mining’ Simulation and Optimisation</td>
<td>To equip the learner to build strategic, tactical and operational simulation models. To enable the learner to apply simulation models in the management and control environment.</td>
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<td></td>
<td>This module covers the design of a cost and production simulation model based on the total production process (reserve to market). The simulation model will incorporate relevant variables and dependencies. Strategic, tactical and operational planning and budgeting will be addressed in terms of the variables and condition-driven standards, as well as the application of the model in an operational management and control environment.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>GLGD7913/23 (725): Mineral Resource Management II (Advanced): Grade control, Ore Balance Sheets, Ore Utilisation</td>
<td>To equip the learner to identify the critical business process variables through evaluation of a production process and to design and implement suitable business changes to enhance value. To evaluate the influence on final product and production cost in the production process. Included are specific business processes, improved knowledge of dilution control, slimes control, plant efficiency, procurement standards, product stockpile optimisation, selective mining, and many others.</td>
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<tr>
<td></td>
<td>The methodology for the evaluation of strategic drivers for the total production process will be discussed. The variables to be evaluated include quality and reliability of information, dilution, production rate, mining method, etc. and how these variables influence one another as well as the final product quality, quantity and cost. In the production environment, the identification and implementation of working procedures for grade control, an ore balance sheet, ore-utilisation and measurement of production rate, system availability and utilisation are covered. Determination of economically recoverable ore and its associated processes will also be included.</td>
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</tr>
<tr>
<td>2</td>
<td>GLGC7933/43 (726): Geological Modelling and Applied Geo-statistics</td>
<td>To equip the learner with the knowledge and ability to make relevant and accurate geological information available to all role players in the production process to enable them to make better decisions.</td>
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<tr>
<td></td>
<td>The importance of accurate and reliable geological information to the short-term mine schedule and production environment is significant. In the mining environment, the most important information is contained in the geological models. Understanding the role of geo-statistics in Mineral</td>
<td></td>
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</tbody>
</table>
Resource Management and how it is used to determine optimum ore-utilisation and product delivery is imperative. Geo-statistical approaches can also be applied strategically to optimise ore-utilisation and maximise product delivery in the long-term.

Table 4: Modules presented in MSc. Mineral Resource management phase 3

<table>
<thead>
<tr>
<th>Phase</th>
<th>Module No</th>
<th>Synopsis</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>GLGE7913/23 (731) Capita Selecta</td>
<td>Course Placeholder</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>GLGE7933/43 (732) Mining Accounting and Modelling</td>
<td>Application of throughput accounting, so that the learner understands how to calculate and make operational financial decisions that guarantee/deliver the required financial returns. Learning what determine optimal profitability, cash-flow and a healthy balance sheet as applied to daily and practical operational performance and improvement decisions, considering efficiencies and productivity. Understanding what necessary inputs are required, why, where and how to obtain it. Basic understanding of financial statements and what they mean. Making of decisions that are based on financial statements and where these decisions lead to. Learn how to define a goal (its boundaries) and what should be evaluated and the function and purpose of assumptions. To create a relevant operational financial decision model, and to calculate this into a net profit, with some basic simulation scenarios for investment ranking. Utilise MS Excel with some practical examples also using return on investment ratios, and know how to decide whether an investment or change should either proceed or not. Understanding what differentiates cash-flow and net profit, and how to apply it.</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>GLGE7953/63 (733): Mineral Resource Management Risk Practices</td>
<td>Application of risk management principles as applied to the minerals industry in terms of Health, Safety and the Environment. Responsibilities of owners, employers and suppliers will be highlighted with special reference to mandatory Codes of Practice (COP’s). The COP’s referred to include Trackless</td>
<td></td>
</tr>
</tbody>
</table>
Mobile Mining Equipment, the Construction of Mine Residue Dumps, the prevention of Rockfall Accidents, Underground Fires and Explosions. Implementation of the MRM programme will be highlighted. The learner will further be exposed to Risk Management Principals that could ensure a safe and healthy working environment.

3 GLGE7973/83 (734): Modern Mining Supply Chain Principles To obtain an overview of the traditional and MRM-adjusted supply chain principles and mining value and supply chain optimisation through; Systems and business process integration, Internal and external collaborative planning and studying the interlinked nature of downstream processes with the ore characteristics and what can be done about it. A case study to aid the learner; in identifying and exploring the hurdles in supply chain optimisation, in exploring ways to plan collaboratively. Mineral Resource Throughput Management requires that the traditional way of thinking about supply chain management needs to be enhanced when applied to the mining industry. Understanding and applying these principles will maximize the current and future profitability of the organisations.

The mining supply chain management module aims at highlighting the key aspects of the process of optimizing the flow of materials, intermediary and final products throughout the chain of operations.

Table 5: Modules presented in MSc. Mineral Resource management phase 4

<table>
<thead>
<tr>
<th>Phase</th>
<th>Module No</th>
<th>Synopsis</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 GLGD7910 Research Dissertation</td>
<td>The subject of the research essay will be chosen in consultation with the course co-ordinator. The candidate must carry out a research task under supervision and present a research essay.</td>
<td>To test the candidates understanding and assimilation of Mineral Resource Throughput Management</td>
<td></td>
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</tbody>
</table>
In total the qualification comprises 204 credits in order to comply with the requirements of the degree. Each module constitutes 120 notional hours (12.5 learning days per module). This is aligned with 12 credits per module, 12 in total required, which adds up to 144 credits. The mini-dissertation contributes 60 credits and adds to the total of 204 credits required. The mini-dissertation requires 600 notional hours or 75 days. This total of 204 credits must be accumulated over a period of 2 years.

A typical module will comprise a period of self-study (from Study material on Dropbox), followed by a workshop of two days, a project/assignment of ten days, as well as time to study for the exam. This will enable learners to study without having to leave their workplace. The module element structure per module and for the dissertation is shown below.

**Figure 4: Module element structure and time requirement**

### 5.1. WORKSHOP SESSIONS

The purpose of the workshops is to bring the candidates from the different backgrounds and functional areas together to discuss the work material and evaluate case studies. Two-day or three-day workshops will be conducted for some of the modules, either at a suitable venue or at the University of the Free State.

If there are sufficient candidates in a specific area, at a specific mine or from a specific company, the workshop will be conducted at the site/mine. It must, however, be stressed that it will be to the advantage of a mine to have the workshop conducted on their premises where some problems inherent to their situation may be addressed, however, at additional cost.
5.2. STUDENT EVALUATION

Evaluation is affected by examination and/or assignments. Learners will be expected to do either a written or an oral examination or hand in an extended assignment for examination purposes. Open-book examinations will be taken. Some of the technical modules will require of the learner to be able to operate a programme and if the learner is already conversant with the program, to produce an application-based project in the MRM sphere.

5.3. PROJECT ASSIGNMENT

Assignments will vary and will have to be discussed with the relevant lecturers. Time spent on these projects will invariably be in the order of 10 days.

5.4. PARTNERSHIPS WITH INDUSTRY PROFESSIONALS AS LECTURERS

The MRM degree makes use of industry professionals (Table 6) to ensure that the content is relevant and that lecturers have the maximum value to add to each module taught.

Table 6: Lecturers partnered with for the MRM degree

<table>
<thead>
<tr>
<th>Lecturer</th>
<th>Short CV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arrie van Niekerk</td>
<td>Arrie van Niekerk obtained his B Eng (Metal) from the University of Pretoria in 1978. He has been the project leader for the implementation of TOC in more than 60 mines and 15 manufacturing companies in South Africa. He has 15 years practical experience in his field and has developed unique solution for enhanced production flow in mining.</td>
</tr>
<tr>
<td>Dr Christina Dohm</td>
<td>Dr Christina Dohm has 37 years’ experience in the mining industry. She has been involved in Mineral Resource Management, Mineral Resource Evaluation &amp; Classification, Independent reviews and the Corporate Governance associated with Competent Persons Reports and Mining Operations and Projects worldwide. She has been a lecturer for the past four decades at various South African universities and continued lecturing and supervising post-graduate students in Geostatistics and MRM since her retirement form Anglo American at the end of 2015.</td>
</tr>
<tr>
<td>Ettienne Bergh</td>
<td>Ettienne completed his studies in industrial engineering at the university of South Africa and has 14 years industry experience in strategic and tactical support in MRM and mine planning through optimisation &amp; integration of long term mine plans to support regional strategy and the development &amp; evaluation of tactical &amp; strategic scenarios to maximise value proposition from regional mineral resource bases. He has been a manager of multi-disciplinary teams supplying MRM services</td>
</tr>
</tbody>
</table>
to mining operations with various operational research & productivity studies in support to ground level & tactical improvement initiatives in simulation modelling and systems and process analyses.

<table>
<thead>
<tr>
<th>Name</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr. Herman Prinsloo</td>
<td>Dr Herman Prinsloo has a Doctor of Philosophy (PhD) Field of Study Cognitive Science from the North-West University, he has over 15 years’ experience in value realisation, organisational change management, continuous Business Improvement (CBI) and Training. He focuses mainly on solving business problems by inventively tweaking people interaction and processes in a business - results are usually instantaneous and measurable. He has worked on projects in 22 countries and has been a lecturer for the MRM program since 2007.</td>
</tr>
<tr>
<td>Johann Grobler</td>
<td>Johan Grobler has been affiliated with the MRM program for over 15 years. He has a M.Eng degree from the University of Pretoria and has worked with other specialists over many years to develop and implement the MRM concepts at various sites with great success. Mr Grobler’s knowledge and understanding of MRM have been</td>
</tr>
<tr>
<td>Michelle Dimmick-Touw</td>
<td>Michelle Dimmick-Touw has 10 years industry experience in management and technical geological roles in coal and base metals in South Africa and Namibia. She completed the Masters in Mineral resource management in 2015 and is currently enrolled to complete a Master’s in Education with focus on open and distance learning.</td>
</tr>
<tr>
<td>Philip Viljoen</td>
<td>Managing Director at RuZults Education, Philip has taught and developed people in Theory of Constraints thinking and applications throughout Southern Africa. He practises as educator, coach and mentor to cause people to think and then act through seeing their potential, developing their vision and supporting them to exceed. His clients get rapid results through unrelenting focus on maximising flow. He has been part of Dr. Eli Goldratt’s inner circle for many years and uses the Theory of Constraints as the basis of his thinking and practise.</td>
</tr>
<tr>
<td>Prof Krige Visser</td>
<td>Prof Krige Visser is a professor with the Graduate School of Technology Management at the University of Pretoria. He has published 23 papers in academic journals and presented more than 30 papers at international conferences. He is registered as a professional engineer (ECSA) and is a council member of the Southern African Asset Management Association. His research interests are maintenance management, reliability management and physical asset management. He has over 31 years of industry experience</td>
</tr>
<tr>
<td>Tumelo Diale</td>
<td>Mr Tumelo Diale is currently a doctor philosophy candidate with his field of study in finance, he completed a of Masters of Management in Finance &amp; Investments from the University of the Witwatersrand as well as the Masters in mineral resource management form the university of the Free State. He has 9 years of experience in the South African mining sector.</td>
</tr>
</tbody>
</table>
6. COST OF THE COURSE

The MRM programme is a two-year course with extra time allowed in the third year to complete the extended research essay. The costs shown in Table 7 are *only indicative* as it doesn’t include the annual inflationary adjustment and costs of books that might change from one year to the next.

**Table 7: Annual costs for the MRM degree**

<table>
<thead>
<tr>
<th></th>
<th>South African Citizens</th>
<th>International Citizens</th>
<th>International Citizens</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Non-SADEC</td>
<td>SADEC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Registration Fees</td>
<td>R1 110.00</td>
<td>R1 110.00</td>
<td>R1 110.00</td>
<td>Included in “Amount paid before Registration”</td>
</tr>
<tr>
<td>International Fee</td>
<td>-</td>
<td>R2 390.00</td>
<td>R2 390.00</td>
<td>Included in “Amount paid before Registration”</td>
</tr>
<tr>
<td>Amount paid before Registration</td>
<td>R 7 420.00</td>
<td>R30 410.00</td>
<td>R19 610.00</td>
<td>Subtracted from tuition fees</td>
</tr>
<tr>
<td>Tuition fees</td>
<td>R7 240x6= R43 440</td>
<td>R7 240x6= R43 440</td>
<td>R7 240x6= R43 440</td>
<td>6 Modules x R7 240 per module</td>
</tr>
<tr>
<td>Dissertation</td>
<td>R8 475</td>
<td>R8 475</td>
<td>GLGD7900</td>
<td></td>
</tr>
<tr>
<td>Exam Fees (6 Modules)</td>
<td>R465x6=R2 790</td>
<td>R465x6=R2 790</td>
<td>R465x6=R2 790</td>
<td>R465.00 per module</td>
</tr>
<tr>
<td>Books</td>
<td>R 2 500.00</td>
<td>R 2 500.00</td>
<td>R 2 500.00</td>
<td>Depends on the modules taken</td>
</tr>
<tr>
<td>Sub-total/year</td>
<td>R 58 315.00</td>
<td>R 60 705.00</td>
<td>R 60 705.00</td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:** Years 1 and 2 extra subjects allowed

**SADEC Countries:** Angola, Botswana, DRC, Lesotho, Malawi, Mauritius, Mozambique, Namibia, Rwanda, Seychelles, Swaziland, Tanzania, Zambia, Zimbabwe

The amount required before registration for every year of study, needs to be paid 5 working days before registration can take place. This amount need not be paid if an official written letter of promise by the company who’ll pay the tuition fees is submitted. Tuition fees may be paid in two equal instalments during the first and second year of studies. All fees are subjected to change and this document gives just an estimation of costs. Costs of pre-scribed books may change. Course information as well as the details for the books is sent to students after registration.

Exams may be written in Bloemfontein (no exam fees applicable) or at a more convenient UFS venue (exam fees applicable) chosen by the student. The cost of exams is dependent on the modules chosen in the year as the method of evaluation may not involve an exam. Expenses for the workshops are included except for travel costs and accommodation costs. These workshops are held twice a year, one in Feb/March (6 working days) and the other in August September (6 working days, includes a weekend). These workshops are compulsory.
7. CONTACT INFORMATION

Should you have any queries regarding the MRM program please contact the members below.

Programme Director:

Michelle Dimmick-Touw
Email: Steenkampme@ufs.ac.za
Tel: 0823375201

Senior Assistant Officer:

Charlene van der Vyver
E-mail: vandervyverc@ufs.ac.za
Tel: 051 401 2393