Mill reline simulation technology

fast, reliable, safe

rmeGlobal.com
Optimised mill relining processes unlock greater mill availability, through-put and mine site profitability.

MILL RELINE DIRECTOR identifies optimisation opportunities by delivering the means to:
- Reduce relining times
- Identify existing mill bottlenecks
- Assess mill layout
- Increase relining predictability
- Reduce waste
- Design effective new plant layout
- Improve relining safety
- Optimise equipment selection
- Optimise relining practices

RME has developed MILL RELINE DIRECTOR, a ‘discrete event’ based mill relining simulation technology. MILL RELINE DIRECTOR creates a virtual representation of your mill and mill reline. This is your Reference Reline which can be developed in several ways. MILL RELINE DIRECTOR reviews the effectiveness of each mill relining activity in the Reference Reline in terms of duration and performance. Through RME, Reline Planners and Grinding Plant designers can apply MILL RELINE DIRECTOR to identify performance improvement opportunities, by changing the various parameters in the virtual reline. These variable parameters include site layout, tool quantities, liner arrangements, labour quantities, labour performance and more. These variables allow the creation of alternative Reline Scenarios. In comparing the Alternative Reline Scenario simulation results with your Reference Reline, optimisation opportunities are identified, reported and quantified.

MILL RELINE DIRECTOR’s memory stores confidential performance data, gathered from a host of relines around the world.

While on site, RME Technicians – MILL RELINE DIRECTOR’s hands – gather site dimensional data.

MILL RELINE DIRECTOR uses up to twelve cameras positioned in and around your mill during a reline. These cameras are MILL RELINE DIRECTOR’s eyes.

The raw data from MILL RELINE DIRECTOR’s hands, eyes and memory is then analysed by RME’s mill optimisation software: MILL RELINE DIRECTOR’s mind.

MILL RELINE DIRECTOR’s voice is a report identifying all of the opportunities for faster and predictable mill relines and shorter shut down durations.

How MILL RELINE DIRECTOR Works

HANDS AND EYES
Reline video capture and/or collection of site dimensional data and data interpretation
Using up to 12 cameras in and around your mill, reline video is captured. Site dimensional data is collected by RME’s MILL RELINE DIRECTOR Engineers. All video footage is then analysed to extract Mill Relining Performance Data. For MILL RELINE DIRECTOR – Plant and MILL RELINE DIRECTOR – Desktop applications, site dimensional data, proposed equipment and site layout data is collected for input into MILL RELINE DIRECTOR.

MEMORY AND MIND
Simulation of a “Reference Reline”
A virtual representation of your mill and mill reline is then constructed from the actual or proposed Site Dimensional Data and Performance Data. This virtual representation of your mill and mill reline is your Reference Reline, imbued with your site’s actual or proposed characteristics and features. This Reference Reline allows relining activities to be assessed in terms of duration and performance.

MIND
Design and simulate Alternative Reline Scenarios
Through RME, Reline Planners and Grinding Plant Designers can use MILL RELINE DIRECTOR to identify and predict performance improvement opportunities, by changing the parameters in the virtual reline. These parameters include site layout, tool quantities, liner arrangements, labour quantities, labour performance and more. Alternative Reline Scenarios are created.

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HANDS
Implementation of recommended changes and Auditing
RME’s MILL RELINE DIRECTOR Engineers assist in managing the implementation of recommended changes. The effectiveness of each implemented change is then audited by a 2nd reline video capture and interpretation from which a new Reference Reline is created. This auditing capability materialises RME’s commitment to visibly, defensibly and sustainably improve our customers’ concentrator performance.

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RME delivers a flexible range of optimisation opportunities through MILL RELINE DIRECTOR:

**FILMED STUDIES** for Brownfield Sites using up to 12 cameras

RME MILL RELINE DIRECTOR can perform a FULL FILMED STUDY using up to 12 cameras in and around your mill. A ‘Reference Reline’ is created, derived from your actual equipment and site constraints and combined with your site’s Performance Data drawn from Reline Video capture and Reline Video interpretation to data analysis.

**NON-FILMED STUDIES** for Greenfield Projects and Brownfield Sites

RME MILL RELINE DIRECTOR can perform a GREENFIELD NON-FILMED STUDY, known as MILL RELINE DIRECTOR ‘PLANT’. A ‘Plant’ Study creates a ‘Reference Reline’, derived from your proposed equipment and proposed site layout and combined with typical site Performance Data held in the database, MILL RELINE DIRECTOR’S Memory.

RME MILL RELINE DIRECTOR can perform a BROWNFIELD NON-FILMED STUDY, known as MILL RELINE DIRECTOR ‘DESKTOP’. A ‘Desktop’ Study creates a ‘Reference Reline’, derived from your actual equipment and actual site constraints and combined with typical site Performance Data held in the database, MILL RELINE DIRECTOR’S Memory.
The Application of Discrete Event Simulation to the Improvement of the Mill Relining Process

Author: Mr Geoff O’Shannassy, MILL RELINE DIRECTOR Development Engineer, Russell Mineral Equipment

Anyone involved in the relining of hard rock grinding mills would agree that it can be a highly unpredictable process, making the task of planning and improving the process of relining quite a challenge. The common approach to this by the relining industry is to estimate the expected duration of a reline using a time per piece, or time per liner, calculation with some allowances included for isolation and de-isolation, inching and the like. This method, however, cannot evaluate, demonstrate or predict the effect on reline time of the introduction of additional labour, additional equipment, site modifications, or the natural variations inherent in a complex process.

A reline simulator was envisaged over 10 years ago as a means of attempting to optimise the reline process. Reline simulation identifies the constraints of the reline at any given site. These constraints can include site layout, reline equipment and reline practices. While relining is similar to a manufacturing process in that it consists of a series of repetitive tasks or processes, the reality of relining is that it occurs in a highly uncontrolled and unpredictable environment. Consequently, creating a simulation of the reline event proved to be too complex for regular programming languages and development environments.

Peter Rubie is Russell Mineral Equipment’s (RME’s) Chief Engineer. In 2009, Mr Rubie observed the relationship between the repetitive nature of manufacturing and the reline process.

This observation, coupled with RME’s abiding focus on discovering methods to visibly, defensibly and sustainably improve our customers’ concentrator performance, motivated Mr Rubie to apply Discrete Event Simulation software, a technology developed in the manufacturing industry, to the creation of a Mill Reline simulator. This simulation model is now known as MILL RELINE DIRECTOR.

Discrete Event Simulation software allows each element of the reline to be programmed with a set of attributes or properties that allow these relining elements to behave and interact with other elements as they would in the real world. For example, in a reline simulation, a hydraulic or pneumatic hammer used to knock in liner bolts is programmed to hit with a certain amount of force at a certain rate and a certain amount of labour is required to operate it. Similarly, a liner bolt is programmed with a certain resistance, location in the mill and is associated with a particular liner. Unlike linear programming, Discrete Event-based simulation relies on the flow of parts through the Reline model. It is this flow of parts which triggers events within the model. For example, once a liner bolt nut and washer are removed, the model is triggered to knock in a liner bolt. The reline model then calls on a hammer to knock in that liner bolt; these hammer and bolt elements interact according to their specific properties, resulting in a specific knock in time for that bolt. In this way the reline model is able to establish a time for each discrete event, or activity, in the reline without breaking rules of precedence, such as removing a liner bolt nut and washer before a bolt can be knocked in. Events in the model occur in a step-by-step manner triggered by the flow of parts through the model, just as they do in the real world. Where tools and labour are available, events may occur in parallel. This flow of parts, and therefore events, continues until every nut, bolt, washer and liner is replaced, triggering the end of the reline.

Real world complexity and randomness is imparted to each of the several hundred elements that make up the Reline model through a series of time frequency distribution curves. These curves are constructed from information drawn out of hundreds of hours of actual reline video footage, footage which has been painstakingly analysed, second by second, to produce thousands of discrete activity times.

Around 50,000 discrete reline activities have been recorded along with associated meta-data for inclusion within the Reline model. A set of tools were required to support the reline data acquisition, pre-processing and Reline configuration. These tools, developed internally by RME, include a set of up to 12 rugged video cameras to capture every minute of the reline; a video editing system and database to hold and manage the data for each reline activity or event; a graphical reline configuration tool to manage and configure the several hundred input data points required to simulate a virtual reline.

The outputs of the MILL RELINE DIRECTOR model were critically evaluated to ensure that the behaviour of the Reline model was consistent with real world observations and relining practices. For example, the need to demonstrate the effects of substituting hammers with various power levels was critical. Two weeks of rigorous hammer testing was performed using a customised test rig, leading to the discovery that a non-linear mathematical model was required to accurately represent the superior performance achieved by using a larger hammer when working on bolts that were stuck or had very high resistance.

The graphical reline configuration tool allows a Reference Reline to be simulated. This Reference Reline is a virtual representation of a site’s current mill, reline set-up and reline practices as captured in the video data. The reline configuration tool then introduces variables to the simulated Reference Reline, giving it the capability to create a series of alternative Reline Scenarios that demonstrate the effect of changes made to plant layouts, equipment types and quantities, labour quantities and much more.

Each Reline Scenario is then compared to the Reference Reline to assess the impact on overall reline time and the effect on individual reline activities or events. Any changes implemented by the site can be audited by MILL RELINE DIRECTOR through a second reline video capture, analysis and simulation. This audit qualifies and quantifies the effects of the changes.

Through MILL RELINE DIRECTOR, Mill Owners and Operators have a visible and defensible means of lowering their operating costs and increasing mill availability.
RME’s passion and mission has always been to minimise Mill Relining time and to increase relining crews’ safety. RME Mill Relining System technologies, used effectively, have quartered the time previously taken to line large mills. Looking forward, RME’s focus is to secure the potential of RME’s Mill Relining System performance for each and every one of our customers, past, present and future.

Our commitment to industry is to visibly, defensibly and sustainably improve our customers’ concentrator performance.

HEAD OFFICE

Toowoomba
Servicing Asia-Pacific, Europe and Middle East
149 Hursley Road
Glenvale, Toowoomba, Queensland 4350 Australia
p +61 7 46 989 100
e rme@rmeGlobal.com

REGIONAL SERVICE CENTRES

Perth
Servicing Asia-Pacific
Unit 3, 73 Discovery Drive cnr Tidal Way
Bibra Lake, Western Australia 6163 Australia
p +61 7 46 995 712
e rme@rmeGlobal.com

Antofagasta
Servicing South America
General Borgoño 934, Piso 4, Of. 401
Antofagasta, Chile
p +56 2 2963 7860
e rme@rmeGlobal.com

Santiago
Servicing South America
Las Garzas 950, Galpón G-H
Quilicura, Santiago, Chile
p +56 2 2963 7860
e rme@rmeGlobal.com

Salt Lake City
Servicing the United States of America
6132 South 380 West
Murray, Utah 84107 USA
p +1 801 871 0500
e rme@rmeGlobal.com

Kamloops
Servicing Canada
755 Carrier Street, Unit B,
Kamloops, BC V2H 1G1 Canada
p +1 250 996 4404
e rme@rmeGlobal.com

Johannesburg
Servicing Africa and South Africa
22 Spartan Road, Spartan, Kempton Park
Gauteng, 1649 South Africa
p +27 87 809 2830
e rme@rmeGlobal.com

RME’s global reach extends to over 345 mine site locations.

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