Fragmentation Measurement Techniques Training Course

Professional Development Training Course Outline

Category	General Training	**Duration**	10 Days
Base Fee	$3,000 USD	**Delivery Mode**	Online / On-site Hybrid

Course Introduction

In the modern mining, quarrying, and civil engineering sectors, fragmentation measurement techniques have evolved from subjective visual assessments into data-driven, highly technical disciplines. Optimal rock fragmentation is the linchpin of mine-to-mill optimization, directly influencing downstream crushing throughput, hauling efficiency, explosives consumption, and overall operational carbon footprints. Fragmentation Measurement Techniques Training Course is meticulously designed to bridge the gap between empirical blasting theories and cutting-edge digital analytics, empowering professionals to transform raw post-blast muckpiles into actionable, high-fidelity engineering insights.

By deploying advanced artificial intelligence (AI), machine learning (ML) image processing, and high-resolution UAV (Drone) photogrammetry, this course deep-dives into the methodologies required to capture and analyze spatial data under volatile field conditions. Participants will navigate the entire lifecycle of fragmentation analysis, from mitigating environmental biases and camera distortion to auditing automated optical software and reconciling 3D point clouds. Through a blend of rigorous physics, data science, and hands-on case studies, this program equips teams to spearhead digital transformation initiatives across their operations.

Programme Curriculum

Fragmentation Measurement Techniques Training Course

Course

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Course Objectives

- Master Digital Image Architecture
- Deploy AI-Driven Segmentation.
- Optimize Mine-to-Mill Value Chains.
- Implement 3D Spatial Analysis
- Execute Statistical Calibration
- Enforce Rigorous QA/QC Data Protocols
- Mitigate ESG & Carbon Footprints.
- Standardize Sampling Methodologies
- Conduct Belt-Scale Real-Time Monitoring.
- Manage Scalability and Site Variables
- Drive Predictive Blast Modeling.
- Govern Edge Computing & Cloud Analytics.
- Cultivate Data-Driven Safety Cultures

Target Audiences

1. Drill and Blast Engineers.
2. Mining & Quarry Operations Managers.
3. Metallurgical & Processing Engineers.
4. UAV Surveyors & Geotechnical Specialists.
5. Continuous Improvement & Digital Transformation Champions
6. Explosives Technical Service Providers.
7. Mine Planning & Optimization Consultants.
8. Health, Safety, and Environmental (HSE) Officers.

Course Modules

Module 1: Foundations of Rock Fragmentation Mechanics

- Physics of rock breakage: Shock wave attenuation vs. gas expansion dynamics.
- Influence of structural geology: Joint sets, bedding planes, and Rock Mass Rating (RMR).
- The historical evolution of size distribution theories and empirical equations.
- Defining the economic "sweet spot" between mine extraction costs and mill processing costs.

- *Case Study:* Analyzing how a Tier-1 copper mine restructured its powder factor to overcome hard rock structural shielding, reducing boulders by 35%.

Module 2: Traditional vs. Next-Generation Measurement Paradigms

- Critical limitations of visual estimation and manual physical screen sieving techniques.
- Introduction to modern non-intrusive spatial measurement and digital sensing.
- Comparative analysis of 2D imaging, 3D photogrammetry, and LiDAR scanning systems.
- Evaluating capital expenditure (CapEx) vs. operational benefits of automated tracking.
- *Case Study:* A gold operation’s shift from high-risk manual belt sampling to automated optical tracking, cutting assay turnaround times from days to seconds.

Module 3: Digital Image Acquisition & Optical Standards

- Camera optics: Selecting optimal focal lengths, sensor resolutions, and shutter speeds for high-speed capture.
- Illumination strategies: Managing harsh sunlight, shadows, and artificial lighting in underground environments.
- Scale placement protocols: Implementing multi-planar references to prevent spatial distortion.
- Ground control points (GCPs) and their role in stabilizing spatial image scale.
- *Case Study:* Overcoming severe shadow distortions in an ultra-deep open-pit iron mine to achieve a 98% image acceptance rate for processing.

Module 4: UAV (Drone) Photogrammetry for Muckpile Mapping

- Designing autonomous flight plans optimized for complex, multi-tiered muckpile topology.
- Overlapping parameters (forward/side) required for accurate orthomosaic reconstruction.
- Transforming raw drone imagery into high-density 3D spatial point clouds.
- Safety regulations, airspace compliance, and weather limitations for field operations.
- *Case Study:* Deploying automated drone mapping post-blast at a large aggregate quarry, capturing 100% of muckpile topography within 15 minutes of detonation.

Module 5: AI and Machine Learning Edge Segmentation

- How convolutional neural networks (CNNs) automate rock boundary delineation.
- Training custom ML models on site-specific geologies to recognize localized rock textures.
- Resolving the "fines problem": How AI predicts sub-pixel distributions where lenses cannot see.
- Manual override workflows: Auditing and correcting algorithm segmentation errors safely.
- *Case Study:* Implementing a deep-learning segmentation model at a limestone operation, reducing manual image editing time by 90%.

Module 6: Empirical Curve Fitting & Statistical Modeling

- Deep dive into the model structure, its variables, and modern modifications.
- Applying the *Rosin-Rammler* mathematical distribution to plot rock fragmentation curves.
- Configuring the characteristic size and uniformity index to predict mill behavior.
- Statistical regression analysis: Validating mathematical models against physical screen tests.
- *Case Study:* Calibrating a modified Kuz-Ram model across five distinct geological domains in a poly-metallic deposit to predict SAG mill throughput within 3% accuracy.

Module 7: Muckpile Segregation & Sampling Bias Mitigation

- The physics of gravity-induced segregation during blast throw and muckpile displacement.
- Mitigating "surface bias": Strategies for analyzing hidden interior profiles during excavation.
- Establishing statistically valid random sampling frequencies throughout the digging cycle.
- Volume-to-frequency adjustments: Compensating mathematically for large structural boulders.
- *Case Study:* Resolving a chronic crushing bottleneck by redesigning the excavation sampling cadence, capturing hidden coarse pockets before they hit the pocket.

Module 8: Real-Time Conveyor Belt Optical Analytics

- Installing continuous, high-speed optical monitoring systems above primary conveyor belts.
- Managing fluctuating material bed heights, belt speeds, and dust clouds.
- Integrating belt speed tachometers with image capture triggers to eliminate motion blur.
- Configuring real-time telemetry alerts for oversize detection to prevent downstream chute blockages.
- *Case Study:* Eliminating primary crusher downtime at a major iron ore plant via an automated belt-line system that triggers an immediate diversion of out-of-spec material.

Module 9: Mine-to-Mill Optimization Frameworks

- Mapping fragmentation variability directly to SAG/Ball mill power draw profiles.
- The role of run-of-mine (ROM) sizing in optimizing primary crusher close-side settings (CSS).
- Balancing drilling and blasting costs against cumulative crushing and grinding costs.
- Simulating structural throughput changes using advanced process digital twins.
- *Case Study:* A comprehensive mine-to-mill project that increased overall plant throughput by 14% through a controlled increase in blasting energy distribution.

Module 10: Underground Fragmentation Measurement Dynamics

- Navigating the unique constraints of confined underground headings, drawpoints, and stopes.
- Specialized mobile and vehicle-mounted fragmentation mapping systems for LHD buckets.
- Addressing complex artificial lighting, moisture, and high-dust atmospheric environments.
- Automating drawpoint fragmentation analysis in block caving operations.
- *Case Study:* Deploying ruggedized, bucket-mounted cameras on underground LHDs to map block cave drawpoint sizing in real-time, preventing secondary breakage delays.

Module 11: 3D Point Cloud Spatial Analytics & LiDAR Integration

- Principles of terrestrial and mobile LiDAR scanning for structural muckpile evaluation.
- Merging photogrammetric orthomosaics with LiDAR data streams for ultra-high fidelity models.
- Calculating true volumetric swelling factors and post-blast rock movement vectors.
- Advanced software environments for handling large-scale spatial datasets efficiently.
- *Case Study:* Utilizing tracking arrays and mobile LiDAR to map spatial displacement vectors, leading to a complete optimization of explosive energy direction.

Module 12: Data Governance, APIs, and Cloud Architecture

- Building scalable enterprise data pipelines to ingest fragmentation data across multiple sites.
- Utilizing APIs to stream real-time sizing metrics into overarching Fleet Management Systems (FMS).
- Structuring database storage for long-term historical trend analysis and machine learning loops.
- Designing actionable executive dashboards that highlight fragmentation KPIs and cost variances.
- *Case Study:* Consolidating data across four international operating sites into a single cloud dashboard, allowing corporate engineering teams to audit blasting performance globally.

Module 13: ESG Compliance: Energy Intensity & Carbon Reduction

- Quantifying the carbon footprint reduction driven by optimized, high-efficiency fragmentation.
- Direct correlations between precision blasting and reduced mechanical secondary breakage needs.
- Measuring the impact of uniform feed sizes on reducing specific grinding energy (kWh/tonne).
- Aligning mine optimization initiatives with global corporate greenhouse gas reduction metrics.
- *Case Study:* A gold mine successfully lowering its processing plant carbon equivalent emissions by 8% purely by narrowing feed sizing variability via digital controls.

Module 14: Managing Geotechnical Variability & Rock Mass Interactions

- Mapping rock mass structural data (RQD, fracture frequency) to expected fragmentation outcomes.
- Adapting explosive loading profiles dynamically based on real-time drill monitoring data (MWD).
- Managing fragmentation in highly complex, structurally faulted, or interbedded geologies.
- Predicting and measuring fines generation in highly friable or altered ore zones.
- *Case Study:* Utilizing automated Measure-While-Drilling (MWD) logs paired with fragmentation imagery to dynamically alter blast designs across highly variable coal overburden.

Module 15: Program Synthesis, Field Auditing, and System Deployment

- Step-by-step blueprint for designing and launching a site-wide fragmentation measurement program.
- Formulating field auditing checklists to maintain long-term camera and software calibration.
- Managing organizational change.
- Future horizons
- *Case Study:* A comprehensive operational review of an international mining house that successfully institutionalized fragmentation metrics across all assets, yielding a 10x ROI on software investments.

Training Methodology

- Interactive lectures and presentations.
- Group discussions and brainstorming sessions.
- Hands-on exercises using real-world datasets.
- Role-playing and scenario-based simulations.
- Analysis of case studies to bridge theory and practice.
- Peer-to-peer learning and networking.
- Expert-led Q&A sessions.
- Continuous feedback and personalized guidance.

Register as a group from 3 participants for a Discount

Send us an email: info@fineskilltrainingcenter.org or call *+254769199797*

Certification

Upon successful completion of this training, participants will be issued with a globally- recognized certificate.

Tailor-Made Course

We also offer tailor-made courses based on your needs.

Key Notes

a. The participant must be conversant with English.

b. Upon completion of training the participant will be issued with an Authorized Training Certificate

c. Course duration is flexible and the contents can be modified to fit any number of days.

d. The course fee includes facilitation training materials, 2 coffee breaks, buffet lunch and A Certificate upon successful completion of Training.

e. One-year post-training support Consultation and Coaching provided after the course.

f. Payment should be done at least a week before commence of the training, to Fineskill Training Center account, as indicated in the invoice so as to enable us prepare better for you

Upcoming Scheduled Sessions

Start Date	End Date	Location	Price
23 Nov 2026	04 Dec 2026	Online	$2,000
23 Nov 2026	04 Dec 2026	Physical	$3,000
23 Nov 2026	04 Dec 2026	Physical	$6,000
23 Nov 2026	04 Dec 2026	Physical	$6,000
23 Nov 2026	04 Dec 2026	Physical	$12,000
23 Nov 2026	04 Dec 2026	Physical	$9,000
23 Nov 2026	04 Dec 2026	Physical	$12,000
23 Nov 2026	04 Dec 2026	Physical	$12,000

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