Digital Twin Mining Systems 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

A Digital Twin Mining System represents the pinnacle of this evolution, creating a dynamic, real-time virtual replica of physical mining assets, processes, and environments. By integrating Internet of Things (IoT) sensor networks, edge computing, and high-fidelity 3D simulations, digital twins bridge the gap between physical operations and digital intelligence. Digital Twin Mining Systems Training Course is designed to equip industry professionals with the critical competencies required to architect, deploy, and manage these sophisticated ecosystems, turning raw spatial-temporal data into actionable, predictive operational intelligence.

As mining environments grow increasingly complex and remote, the ability to orchestrate operations virtually is no longer a luxury it is a competitive necessity. This curriculum focuses heavily on industry-standard frameworks, navigating the complexities of cyber-physical systems (CPS), predictive maintenance analytics, and autonomous fleet optimization. Participants will master the art of synthesizing disparate data streams from automated haulage telemetry to subterranean geological modeling into a unified, single source of truth.

Programme Curriculum

Digital Twin Mining Systems Training Course

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Course Duration

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Course Objectives

1. Master Cyber-Physical Integration.
2. Implement Predictive Asset Management.
3. Optimize Autonomous Fleet Operations.
4. Enhance Subterranean Situational Awareness.
5. Execute High-Fidelity Mine-to-Plan Alignment.
6. Deploy Edge Computing Architectures.
7. Drive Sustainability via Carbon Twins.
8. Synthesize Multi-Source Geospatial Data.
9. Formulate Synthetic Training Datasets.
10. Establish Robust Cyber-Mining Security
11. Leverage Generative AI and LLMs.
12. Accelerate Interoperability with Open Standards.
13. Quantify Digital Twin ROI.

Target Audience

- Mining Operations Directors & VPs.
- Automation & Control Systems Engineers.
- Mine Planning & Geological Engineers
- Data Scientists & Analytics Specialists
- Maintenance & Reliability Engineers.
- Health, Safety, and Environment (HSE) Managers.
- Digital Transformation & Innovation
- Fleet Management Systems (FMS) Operators.

Course Modules

Module 1: Foundations of Digital Twins in Modern Mining

- Defining the architecture of cyber-physical systems (CPS) in heavy industry.
- The evolution from static 3D CAD modeling to dynamic, real-time reactive virtual twins.
- Analyzing the industry 4.0 maturity model for global mining enterprises.
- Mapping data ingestion pipelines from physical assets to cloud environments.
- *Case Study:* How a Tier-1 iron ore producer reduced operating costs by 15% using an enterprise-wide digital twin framework.

Module 2: IoT Sensor Networks and Telemetry Ingestion

- Deploying ruggedized sensor arrays across open-pit and underground machinery.
- Protocols for low-latency industrial data transmission: MQTT, OPC UA, and Kafka.

- Managing data density, noise filtering, and edge-side data deduplication.
- Time-series database architecture optimized for high-frequency mining telemetry.
- *Case Study:* Overcoming connectivity bottlenecks in a deep underground gold mine using mesh Wi-Fi and MQTT data brokers.

Module 3: Spatial Data Infrastructure (SDI) and 3D GIS Integration

- Synthesizing macro-level GIS mapping with micro-level equipment digital assets.
- Processing and streaming large-scale LiDAR point clouds and drone photogrammetry.
- Maintaining coordinate system alignment between dynamic mine plans and virtual spaces.
- Implementing open spatial standards (OGC) for seamless multi-platform visualization.
- *Case Study:* Dynamic volumetric tracking of a copper stockpile using automated drone scans and spatial twin synchronization.

Module 4: Autonomous Fleet Orchestration & Simulation

- Integrating Autonomous Haulage Systems (AHS) into the central digital twin core.
- Real-time collision avoidance, path planning, and dynamic traffic management simulation.
- Predictive modeling of tire wear, fuel consumption, and battery cycle life for electric fleets.
- Simulating human-machine interaction profiles in hybrid autonomous environments.
- *Case Study:* Optimizing a fleet of 50 autonomous haul trucks in the Pilbara region to increase daily throughput by 8%.

Module 5: Predictive Maintenance & Asset Health Analytics

- Building physics-informed machine learning models for structural components (e.g., excavators, crushers).
- Early anomaly detection using vibration, acoustic, and thermal telemetry.
- Calculating Remaining Useful Life (RUL) metrics for high-value rotating components.
- Automating work-order generation within Enterprise Asset Management (EAM) systems.
- *Case Study:* Eliminating catastrophic failures on a primary SAG mill through early-stage bearing anomaly detection.

Module 6: Processing Plant & Comminution Optimization Twins

- Developing thermodynamic and kinetic process models within a virtual plant twin.
- Real-time mass and energy balancing across crushing, grinding, and flotation circuits.
- Utilizing machine vision twins to monitor conveyor belt particle size distribution in real time.
- Closed-loop control optimization utilizing Reinforcement Learning (RL) agents.
- *Case Study:* Boosting recovery rates by 2.3% at a polymetallic processing facility using a digital process twin.

Module 7: Underground Ventilation & Environmental Control Twins

- Dynamic thermodynamic modeling of complex underground ventilation networks.
- Integrating real-time gas sensor arrays into the spatial model.
- Simulating Ventilation-on-Demand (VoD) schedules based on active fleet locations.
- Predictive heat stress indexing and cooling infrastructure optimization.
- *Case Study:* Reducing ventilation energy consumption by 30% while improving air quality index safety margins in an ultra-deep nickel mine.

Module 8: Short-Term Mine Plan to Production Alignment

- Real-time tracking of shovel and excavator face positions against block models.
- Dynamic grade control optimization through continuous telemetry-driven assay updates.
- Identifying operational drift and compliance-to-plan variances instantly.
- Automated re-routing schedules for material dispatch based on ore blending constraints.
- *Case Study:* Minimizing ore dilution margins from 8% to 2% through high-precision shovel-twin tracking.

Module 9: Tailings Dam Stability & Environmental Monitoring Twins

- Synthesizing satellite InSAR data, piezometer readings, and water tables into a structural twin.
- Predictive modeling of liquefaction and seepage risks under extreme weather scenarios.
- Real-time effluent and acid rock drainage (ARD) dispersion modeling.
- Automating early-warning notification protocols for downstream communities.
- *Case Study:* Implementing a continuous risk-assessment twin for a Tier-1 tailings storage facility in South America.

Module 10: Human Performance, Safety, & Immersive XR Twins

- Connecting personnel wearables (biometrics, proximity sensors) to the central safety twin.
- Deploying Virtual and Augmented Reality (VR/AR) for high-hazard procedural training.
- Simulating emergency evacuation and escapeway routing scenarios under zero-visibility conditions.
- Designing augmented dashboards for remote operations center (ROC) controllers.
- *Case Study:* Reducing onboarding time for heavy equipment operators by 40% using high-fidelity VR simulator twins.

Module 11: Edge Computing & Low-Latency Architecture at the Mine Face

- Designing hybrid edge-cloud topologies for remote, bandwidth-constrained operations.
- Deploying micro-data centers and containerized applications (Docker/Kubernetes) at the site.
- Real-time inference of computer vision models directly on mobile equipment.
- Data synchronization strategies during prolonged network disconnect events.
- *Case Study:* Deploying edge compute clusters on smart drill rigs to enable real-time rock strata identification during drilling.

Module 12: Generative AI and Conversational Digital Twins

- Integrating Large Language Models (LLMs) with industrial digital twin databases.
- Building natural language interfaces for real-time querying of asset status and history.
- Automated generation of incident reports and shift-handover documentation from twin data.
- Utilizing generative algorithms to optimize mine design and haulage layouts.
- *Case Study:* Implementing an AI voice assistant in a Remote Operations Center allowing dispatchers to query asset health hands-free.

Module 13: Cyber-OT Security for Digital Twin Infrastructures

- Identifying vulnerabilities across the IT/OT convergence layer in digital twin networks.
- Implementing Zero Trust network architectures and cryptographic device identities.
- Securing API endpoints connecting third-party analytics platforms to the twin core.
- Designing incident response protocols for cyber-physical tampering detection.
- *Case Study:* Deflecting a simulated ransomware attack on an automated rail-loading twin system using network segmentation.

Module 14: Data Governance, Interoperability, & Open Standards

- Implementing the Asset Administration Shell (AAS) framework for unified asset definitions.
- Structuring data lifecycles from ingestion to cold-storage archiving.
- Navigating multi-vendor data silos and implementing open APIs for software integration.
- Enforcing data quality, pedigree, and standardization across international operations.
- *Case Study:* Standardizing asset data definitions across four disparate legacy mining fleets into a singular digital twin repository.

Module 15: Scaling Enterprise Digital Twins and ROI Measurement

- Building a business case, assessing capital expenditures (CapEx), and calculating operational savings (OpEx).
- Phased rollouts: Moving from single-asset pilots to fully integrated enterprise twins.
- Establishing organizational change management strategies for digital transition adoption.
- Defining and tracking digital twin value KPIs (e.g., OEE boost, carbon reduction, hazard mitigation).
- *Case Study:* A global mining conglomerate's journey scaling digital twin tech across 12 international sites, achieving full ROI within 18 months.

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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