Applications Deep Dive for Metallurgy

A modular series of hands-on technical workshops

Target audience

Engineering and technical professionals in metallurgy and related industries who want to move from AI concepts to practical implementation, including: process, production and quality engineers, maintenance and reliability engineers, R&D and materials engineers, Data/IT specialists working closely with operations, technical managers and team leads.

Workshop goal

To give technical teams a practical, hands-on understanding of key AI application areas in metallurgy, showing how the models work (including physics-informed and hybrid ML), what data is needed and at what quality level, and how these solutions create measurable value in real industrial environments.

Learning outcomes

After this workshop, participants will be able to:

- Understand the core AI techniques and model types behind major application areas.
- Translate business and process challenges into well-defined AI use cases with clear data and model requirements.
- Interpret model outputs and performance metrics in an engineering context.
- Assess data availability and quality for each application type.
- Collaborate effectively with data science and vendor teams during design, development and deployment.

Formats

The series is modular and can be tailored to your needs:

- **Focused module (2–3 hours)**
  Deep dive into a single AI application area that is most relevant for your company, with targeted examples, model walkthroughs and data discussions.
- **Comprehensive 1-day workshop (4–6 hours)**
  Overview and deeper exploration of multiple AI applications in metallurgy, going beyond the “AI Fundamentals” workshop into model choices, data pipelines and implementation details.

Workshop structure and modules

Each module follows a common structure:

- Business/process context
- Data and model foundations (incl. data quality and, where relevant, physics-informed ML)
- Case examples
- Practical do's and don'ts

MODULE 1 Predictive Maintenance with AI

- Maintenance use cases in metallurgy and process equipment.
- Typical data (signals, sensors, maintenance history) and key quality issues.
- Main model types for degradation, anomalies and failure risk, and when they make sense.

MODULE 2 AI-Powered Quality Control & Defect Detection

- Inline and end-of-line quality control for metal products and surfaces.
- Image, lab and process data, and what "good enough" data looks like.
- Core models from classical ML to deep learning vision, plus where physics-informed constraints help.

MODULE 3 Digital Twins for Metallurgical Processes

- Digital twins for furnaces, casting, rolling and other unit operations.
- Combining process data, physics-based models and data-driven/physics-informed ML.
- Typical use cases: what-if, optimization and decision support for operators.

MODULE 4 Supply Chain Optimization & Demand Forecasting

- AI for planning in metals: forecasting, inventory and scheduling.
- Key data sources and quality concerns (volatility, seasonality, constraints).
- Forecasting and optimization models, and how to embed business and physical rules.

MODULE 5 AI for Microstructure Analysis & Materials Development

- Linking process parameters, microstructure and material properties with AI.
- Image and test data requirements and common challenges.
- Vision and surrogate models, including physics-informed setups that respect metallurgical knowledge.

MODULE 6 Powder Metallurgy & Additive Manufacturing Automation

- AI in powder production and AM: monitoring, quality and parameter optimization.
- Machine, sensor and inspection data across the full AM chain.
- Models for process signatures and defect prediction, including hybrid physics-aware approaches.

Interactive elements

Each module includes tailored interactive components, for example:

- Short diagnostics: “Where are we today?” for the specific application area (processes, data and models).
- Case study discussions: metallurgy-focused examples showing both successful and failed projects, with emphasis on model choice (data-driven vs. physics-informed/hybrid) and data quality.
- Group exercises: mapping the application to participants’ own assets, lines or products, and listing required data sources, quality improvements and opportunities to use physics-informed ML.
- Implementation checklist: participants leave each module with a concrete list of next steps (data gaps, stakeholders, candidate models, pilot ideas) for their organization.
